Specifications

For

MACOMB COMMUNITY COLLEGE
SKILLED TRADES
and
ADVANCED TECHNOLOGY CENTER

BIDS

By:

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H+B Job No. 18-719
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SECTION 00 0107
DIRECTORY

Project	Macomb Community College Skilled Trades and Advanced Technology Center
Owner	Macomb Community College 14500 East 12 Mile Road Warren, MI 48088
Architect	Hobbs+Black Associates, Inc. 100 N. State Street Ann Arbor, MI 48104
Civil Engineer	Anderson, Eckstein and Westrick, Inc 51301 Schoenherr Rd. Shelby Twp., MI 48315
Structural Engineer	Resurget Engineering 4219 Woodward Ave., Suite 306 Detroit, MI 48201
Mechanical /Electrical Engineer	Peter Basso Associates, Inc. 5145 Livernois, Suite 100 Troy, MI 48098
Construction Manager	Barton Malow Builders 26500 American Drive Southfield, MI 48034
Door Hardware Consultant	Allegion, PLC 44704 Helm St. Plymouth MI 48170

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SECTION 01 2300
ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section:
   1. Contractor's Construction Schedule.
   2. Submittals Schedule.
   3. Daily construction reports.
   4. Field condition reports.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into project.
   1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications for alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Mandatory Alternate #1: Delete procurement of welding booths. Owner to provide welding booths for contractor installation.

B. Mandatory Alternate #2: Delete removal and replacement of existing roofing, insulation and metal coping. New roofing at addition area and all flashings and tie-in are to be provided base bid. Penetration patching on the existing roofing systems to be provided base bid.

C. Mandatory Alternate #3: Delete removal and replacement of existing window systems in the east and west wing narrow openings as identified on the drawings.

D. Mandatory Alternate #4: Delete resilient tile flooring and base in the east and west wing corridors. Existing terrazzo flooring to remain in these areas.

E. Mandatory Alternate #5: Delete the cleaning and sealing of existing precast concrete and cleaning of existing face brick.

F. Mandatory Alternate #6: Delete finish work in the south upper level mezzanine. Delete stairs/railing system and interior finishes. Refer to electrical for revision to lighting systems.

END OF SECTION 01 2300

SECTION 01 9113
COMMISSIONING 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 work of this section.
B. Related Sections include the following:
   1. Division 20 Sections.

1.2 DESCRIPTION

A. Purpose
   1. Verify operation and functional performance of the systems and equipment for compliance with "Design Intent," and contract documents.
   2. Document system tests and inspections.
   3. Verify application of operation and maintenance manuals, record documents, spare parts listing, special tools listing, and other items as may be specified herein for support of systems and equipment.
   4. Coordinate and direct training of personnel for operation and maintenance of systems and equipment.
B. General
   1. Furnish labor and material to accomplish complete commissioning as specified herein.
   2. Complete interim commissioning of systems during initial season operation and follow up commissioning of required systems during additional season operation.

1.3 QUALITY ASSURANCE

A. Reference: ASHRAE Guideline 0-2005, “The Commissioning Process.”
B. Reference: ASHRAE Guideline 1-1996, “HVAC Commissioning Process.”
C. International Electrical Testing Association – NETA Acceptance Testing Specifications – ATS– 1996.
D. Contractor's Test Engineer: The Contractor's Test Engineer shall have experience in the start-up and troubleshooting of Mechanical and Electrical systems, shall be generally familiar with the test and balance of Mechanical systems, shall be generally familiar with temperature control systems, shall have excellent organizational skills, shall have excellent written and oral communication skills, and shall be able to work well with the Owner, the Engineer, and the trades subcontractors. The Contractor's test engineer may be a qualified employee of the Contractor's staff, a qualified

employee of a subcontractor's staff, or a qualified outside party hired by the Contractor.

1.4 RESPONSIBILITIES

A. Contractor

1. Assure participation and cooperation of subcontractors (mechanical, temperature controls, TAB, etc.) under his jurisdiction, and suppliers (air handling units, Heat exchangers, pumps, etc.), as required for the commissioning process.
2. Be responsible for providing labor, material, equipment, etc., required to facilitate the commissioning process.
3. Provide the services of a qualified Test Engineer to develop and direct the implementation of the Commissioning Plan. Refer to the "Quality Assurance" portion of this Section for required qualifications of the Contractor's Test Engineer.
4. Attend the commissioning meetings (to be held every two to four weeks, depending on progress and as required for the systems to be commissioned) which include the Contractor's Test Engineer, the Owner, the Commissioning Authority, and appropriate subcontractors and suppliers. The purpose of these meetings shall be to coordinate and schedule commissioning activities. The Contractor shall coordinate the attendance of the appropriate subcontractors and suppliers.
5. Incorporate in the project construction schedule those elements related to commissioning activities.
6. Prepare system test reports (pipe pressure tests, duct pressure/leak tests, etc.), submit to commissioning authority for review, and insert in appropriate location of the commissioning manual.
7. Prepare equipment/system installation and start-up reports for each piece of equipment/system to be commissioned. Submit completed reports to commissioning authority for review and insert reports in appropriate location of the commissioning manual.
8. Maintain the project commissioning manual. Contractor shall keep the project commissioning manual on site throughout the project for use by the commissioning team. Contractor shall insert all test reports prepared by the Contractors, equipment installation reports prepared by the Contractors, and equipment start-up reports prepared by the Contractor in the appropriate locations of the commissioning manual. At the completion of the commissioning process the Contractor shall submit four (4) copies of the completed commissioning manual to the Owner.
9. Coordinate, schedule, start-up, and functional testing of equipment and systems (coordinated by the Contractor's Test Engineer). *NOTE: ADDITIONAL TIME OR TRAVEL EXPENSES INCURRED BY THE COMMISSIONING authority DUE TO CANCELLED OR POSTPONED TESTING, OR DUE TO EQUIPMENT NOT BEING READY FOR FUNCTIONAL TESTING WHEN SCHEDULED SHALL BE PAID TO THE COMMISSIONING AUTHORITY BY THE CONTRACTOR*.
10. Provide labor, equipment, and material required to perform, equipment start-up and functional tests as directed by the Commissioning Authority. Document functional testing results, noting actual performance versus design requirements. The functional testing shall include operating the system and components through each of the written sequences of operation, and other significant modes and sequences, including startup, shutdown, unoccupied mode, manual mode, staging, miscellaneous alarms, power failure, security alarm when impacted and interlocks with other systems or equipment. Sensors and actuators shall be calibrated during construction check testing by the installing Contractors and spot-checked by the commissioning agent during functional testing. Tests on respective HVAC equipment shall be executed during both the heating and

cooling seasons. However, some overriding of control values to simulate conditions shall be allowed. Functional testing shall also include control system trend logs, and read-outs or stand-alone data loggers, to provide a high level of confidence in proper system function, as deemed appropriate by the commissioning consultant and the building Owner.

11. Coordinate the training of Owner personnel. Refer to the individual specification Sections for Owner training requirements. In addition to the Owner training specified in the individual specification sections, provide two (2) Owner training sessions, each four (4) hours in length, on the operation of the system as a whole.
12. Assemble/develop complete Operations and Maintenance Manuals. A draft copy of the O & M shall be submitted early in project and be available on site during commissioning. Final copy shall be submitted prior to substantial completion of the project.

B. Commissioning Authority:
   1. Develop the commissioning manual.
   2. Participate in critical construction progress meetings, and review all construction progress meeting notes.
   3. The Commissioning Authority shall hold regular commissioning meetings (to be held every two to four weeks, depending on progress and as required for the systems to be commissioned). The Commissioning Authority shall schedule the meetings, notify the Owner and the Contractor, and record and submit minutes from these meetings to the Owner for distribution to the Contractor.
   4. Participate in the review of document clarification requests.
   5. Participate in the review of field orders and bulletins.
   6. Participate in compliance reviews of submittal documents (shop drawings and submittals).
   7. Provide construction progress observations, with documentation and recommendations to the Owner's Project Construction Representative.
   8. Verify testing by witnessing the tests, or verify testing by reviewing documentation of testing witnessed by others.
   9. Participate in the observation and review of functional tests on systems being commissioned.
   10. Review final record documents (i.e., operation and maintenance manuals, as-built drawings, etc.).

C. Owner:
   1. Establish contracts:
      a. Owner-Engineer Agreement for design.
      b. Owner-Contractor Contract for construction.
      c. Owner-Commissioning Authority Agreement for observation and review of the commissioning process.
   2. Attend the commissioning meetings.
   3. Verify testing by witnessing the tests, or verify testing by reviewing documentation of testing witnessed by others.
   4. Participate in the observation and review of functional tests on systems being commissioned.
   5. Review final record documents (i.e., operation and maintenance manuals, as-built drawings, etc.).
   6. Participate in Owner Training provided by the Contractor.

1.5 SUBMITTALS

A. Submit under provisions of the specification and as supplemented in this section.
B. Prepare system test reports (pipe pressure tests, duct pressure/leak test, electrical tests, etc.), submit to commissioning authority for review, and insert in appropriate location of the commissioning manual.

C. Prepare equipment/system installation and start-up reports for each piece of equipment/system to be commissioned. Submit completed reports to commissioning authority for review and insert reports in appropriate location of the commissioning manual.
D. The Contractor shall submit Owner training plans.
E. The Contractor shall show in the Project schedule the order and timing of the Commissioning Plan for each of the systems to be commissioned.
F. Draft copy of the project O & M manuals shall be submitted early in the construction phase and be available on site for use during commissioning.

1.6 PROJECT RECORD DOCUMENTS

A. Submit four (4) copies of the as-built Commissioning Manual after completion of commissioning. As-built Commissioning Manual shall include:
   1. Completed (initialed) Commissioning Plan/Sign-off List for each system which was commissioned.
   2. As-built description of operation for each system which was commissioned.
   3. Completed (checked-off) functional test plan/checklist for each system which was commissioned.
   4. Piping system certified pressure test report (where applicable) for each system which was commissioned.
   5. Piping system flushing and cleaning report (where applicable) for each system which was commissioned.
   6. Inspection Certificates (where applicable) for each system which was commissioned.
   7. Duct System Pressure/Leak Test Reports.
   8. Manufacturer on-site installation/start-up test reports for equipment of commissioned systems.
   9. Documentation of the dates and times during which Owner training took place for each system which was commissioned.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Instrumentation shall be provided by the Contractor performing tests.

PART 3 - EXECUTION

3.1 MECHANICAL SYSTEMS TO BE COMMISSIONED

A. Hot water heating system and equipment.
B. Chilled water system.
C. Air handling systems.
D. Exhaust fans and ventilation fans/systems.
E. Air terminal units.
F. Unit heaters.
G. Perimeter radiation heating devices.
H. Temperature controls.

3.2 ELECTRICAL SYSTEMS TO BE COMMISSIONED

A. Normal power distribution.
B. Emergency power distribution.
C. Uninterruptible power distribution.
D. Lighting systems.
E. Fire alarm systems.
F. Security systems.

3.3 COMMISSIONING PLAN

A. The following is a general outline of the commissioning plan. It includes, but is not limited to the following items, as applicable:
   1. Submit shop drawings and product data.
   2. Submit Commissioning Manuals for review, prior to beginning the commissioning process. Refer to the "SUBMITTALS" portion of this section for requirements.
   3. Submit draft copies of Operations and Maintenance manuals for review.
   4. Submit Training Plan.
   5. Submit verification that all pressure testing, flushing and cleaning has been completed for piping systems.
   6. Submit duct pressure/leakage test reports.
   7. Submit Inspection Certificates.
   8. Submit verification of start-up tests for equipment and systems.
   9. Submit air and water balance report.
   10. Complete testing of the functional performance of all components of each system to be commissioned. (Note Requirements in paragraph 1.4.A.10 in this section)
   11. Any test which cannot be accomplished for seasonal or other reasons, or for which acceptable performance is not achieved, shall be rescheduled to a time when it can be accomplished.
   12. Participate in substantial completion walk-through.
   13. Submit warranties.
   14. Submit record documents, including but not limited to as-built drawings, final operations and maintenance manuals and completed Commissioning Manual.
   15. Conduct training of Owner personnel.

B. At the end of the process, every mode of the commissioned systems operation, all commissioned system equipment and components, and every item in the control sequences shall have been proven operational under all normal operational modes, including part and full load, and under normal and emergency conditions.

END OF SECTION 01 9113

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SECTION 02 4119
SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the Demolition and removal of selected portions of building or structure, including but not limited to the following:
   1. Interior and exterior load-bearing and non-load bearing partitions.
   2. Footings and foundations.
   3. Accordion partitions.
   4. Flooring and ceilings.
   5. Aluminum entrance and storefront systems. (Refer to Mandatory Alternate #3)
   6. Louvers and tunnel areaway access.
   7. Concrete slabs, stairs and ramps.
   8. Roofing membrane, insulation, flashings and copings. (Refer to Mandatory Alternate #2)
   9. Penthouse steel mansard and wall opening for mechanical access.
   10. Removal of associated mechanical and electrical items.
   11. Salvage of face brick for re-installation.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site. Remove noted items completely. Patch surrounding construction to match adjacent surfaces.

B. Existing to Remain: Existing items of construction that are not to be removed.

1.4 SUBMITTALS

A. Qualification Data: For demolition firm.

B. Schedule of Selective Demolition Activities: Indicate the following:
   1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
   2. Means of protection for items to remain and items in path of waste removal from building.

C. Pre-demolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Submit before Work begins.

1.5 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project and who can demonstrate not less than 5 years of successful experience.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 and NFPA 241.

1.6 PROJECT CONDITIONS

A. Owner will occupy buildings immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical. Owner will remove items to be salvaged prior to demolition operations.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Storage or sale of removed items or materials on-site is not permitted.

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations. Do not interrupt Owner’s continued service in occupied buildings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

D. Record existing conditions by use of measured drawings and preconstruction photographs.

E. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
2. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
    a. Where entire wall is to be removed, existing services/ systems may be removed with removal of the wall.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not

hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly.

B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition, cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SALVAGE OF BRICK

A. Salvage all removed brick for reuse as replacement bricks.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 4119

SECTION 03 0130
CONCRETE REHABILITATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes the following:
   1. Removing rusting metal and ore particles and patch.
   2. Cleaning exposed concrete surfaces.
   3. Patching spalled areas and areas where rusted metal particles were removed.
   4. Sealers.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification data: For installers and testing agency.
   1. For products required to be installed by workers approved by product manufacturers, include letters of acceptance by product manufacturers certifying that installers are approved to apply their products.

1.4 QUALITY ASSURANCE

A. Restoration Specialist Qualifications: Engage an experienced restoration and cleaning firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Installer shall employ workers trained and approved by manufacturer to apply sealers.

B. Mockups: Prepare mockups of restoration and cleaning to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Cleaning: Clean an area approximately 25 sq. ft.
   2. Sealer: Seal an area approximately 25 sq. ft.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of 140 to 160 deg F.

C. Job-Mixed Detergent Solution: Solution prepared by mixing 2 cups of tetrasodium polyphosphate, ½ cup of laundry detergent, and 20 quarts of hot water for every 5 gal. of solution required.

D. Job-Mixed Mold, Mildew, and Algae Remover: Solution prepared by mixing 2 cups of tetrasodium polyphosphate, 5 quarts of 5 percent sodium hypochlorite (bleach), and 15 quarts of hot water for every 5 gal. of solution required.

2.2 SEALER

A. Design Standard: BASF Hydrozo Clear Double 7 VOC; clear, solvent-based, VOC-compliant, water-repellent sealer for porous substrates.

B. Acceptable Manufacturers subject to compliance with requirements:
   1. BASF
   2. Chemprobe
   3. ProSoCo

2.3 PATCHING MORTAR

A. Patching Mortar, General:

   1. Unless otherwise indicated, use any of the products specified n this Article.
   2. Overhead Patching Mortar: For overhead repairs, use patching mortar recommended by manufacturer for overhead use and as specified in this Article.
   3. Coarse Aggregate for Adding to Patching Mortar: Washed aggregate complying with ASTM C 33, Size No. 8, Class 5S. Add only as permitted by patching mortar manufacturer.

B. Polymer-Modified, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, That contains a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.

   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. AQUAFIN, Inc.; MORTAR-40.
      b. CGM, Incorporated; Pro Trowel Mortar, Pro Gel Mortar, Pro Flowable Mortar, Pro N.B.P.

c. Dayton Superior Corporation; HD-50 or Thin Resurfacer.
d. Euclid Chemical Company (The); Concrete Coat, Thin Coat or Verticoat.
e. Fox Industries, Inc.; FX-243 or FX-273 Trowel Grade Polymer Repair Mortar.
f. Kaufman Products, Inc.; Patchwell, Patchwell Kit, Patchwell Kit D, or Patchwell Kit HB.
g. MBT Protection and Repair, Div. of ChemRex; Emaco R320 CI or Emaco R350 CI.
h. Meadows, W.R., Inc.; Sealtight Meadow-Patch T1 or Sealtight Meadow-Crete FNP.
i. Sika Corporation; SikaTop 121 Plus, SikaTop 122 Plus, Sika Top 123 Plus, or SikaTop 126 Plus.
j. Sonneborn, Div. of ChemRex; Screed, Sonopatch 100, Sonopatch 200, Sonopatch 300.
k. Sto Corp., Concrete Restoration Division; Sto Flowable Mortar, Sto Overhead Mortar, Sto Thin-Coat Mortar or Sto Trowel-Grade Mortar.
l. Tamms Industries, Inc.; Duraltop Fast Set or Speed Crete PM.
m. ThorRoc, Div. of ChemRex, Inc.; HB2 Repair Mortar or Polyset.
n. US MIX Products Company; US Spec Polypatch FR or US Spec Thinpatch.

2.4 MIXES

A. Mix products, in clean containers, according to manufacturer's written instructions.

1. Add clean silica sand and coarse aggregates to products only as recommended by manufacturer.
2. Do not add water, thinners, or additives unless recommended by manufacturer.
3. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
4. Do not mix more materials than can be used within recommended open time. Discard materials that have begun to set.

PART 3 - EXECUTION

3.1 CLEANING, GENERAL

A. Proceed with cleaning in an orderly manner; work from bottom to top/top to bottom of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water will not wash over cleaned, dry surfaces.

B. Use only those cleaning methods indicated for each material and location.

1. Do not use wire brushes or brushes that are not resistant to cleaner being used. Do not use plastic-bristle brushes if natural-fiber brushes will resist cleaner being used.

2. Use spray equipment that provides controlled application at volume and pressure indicated, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage precast concrete.
    a. Equip units with pressure gages.
3. For water-spray application, use fan-shaped tip that disperses water at an angle of 25 to 50 degrees.
4. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F at flow rates indicated.

C. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces including corners, and that produces an even effect without streaking or damaging surfaces.

D. Water-Spray Application Method: Unless otherwise indicated, hold spray nozzle at least 6 inches from surface and apply water in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.

3.2 PRELIMINARY CLEANING

A. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used. Extraneous substanes include paint, calking, asphalt, and tar.

1. Carefully remove rusting metal and ore particles and patch.
2. Carefully remove heavy accumulations of material from surface with sharp chisel. Do not scratch or chip surface.
3. Remove paint and calking with alkaline paint remover.
    a. Comply with requirements in “Paint Removal” Article.
    b. Repeat application up to two times if needed.
4. Remove asphalt and tar with solvent-type paint remover.
    a. Comply with requirements in “Paint Removal” Article.
    b. Apply paint remover only to asphalt and tar by brush without prewetting.
    c. Allow paint remover to remain on surface for 10 to 30 minutes.
    d. Repeat application if needed.

3.3 CLEANING ARCHITECTURAL CONCRETE

A. Detergent Cleaning:

1. Wet surface with cold/hot water applied by low-pressure spray.
2. Scrub with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with cold/hot water applied by low/medium-pressure spray to remove detergent solution and soil.
4. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

3.4 PREPARATION

A. Protect people, motor vehicles, equipment, surrounding construction, Project site, plants, and surrounding buildings from injury resulting from concrete rehabilitation work.
   1. Dispose of runoff from wet operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors

B. Surface Preparation for Sealers: Clean concrete by low-pressure water cleaning or detergent scrubbing to remove dirt, oils, films and other materials detrimental to sealer application.

3.5 APPLICATION

A. General: Comply with manufacturer's written instructions and recommendations for application of products, including surface preparation.

B. Patching Mortar: Unless otherwise recommended by manufacturer, apply as follows:

   1. Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent into substrate, filling pores and voids.
   2. Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.
   3. For vertical patching, place material in lifts of not more than 1 inch, or less than 1/8 inch. Do not feather edge.
   4. For overhead patching, place material in lifts of not more than 1 inch, or less than 1/8 inch. Do not feather edge.
   5. After each lift is placed, consolidate material and screed surface.
   6. Where multiple lifts are used, score surface of lifts to provide a rough surface for application of subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.
   7. Allow surfaces of lifts that are to remain exposed to become firm and then finish to match existing surface.
   8. Wet-cure cementitious patching materials, including polymer-modified, cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

C. Sealer:
   1. Confirm all patching repairs and sealants are fully cured.
   2. Confirm all surfaces are thoroughly cleaned and dry.
   3. Apply with low pressure, non-atomizing sprayer at manufacturer's recommended application rate, with a controlled rundown.

4. Test area approximately 5’ x 5’ before general application to verify application technique and results. Allow product to cure 7 days before evaluating test. Perform Rilem tube test and splash test in presence of Owner’s representative.

END OF SECTION 03 0130

SECTION 03 3000
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Do not add water at job site.

C. 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:

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete Work 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. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
   1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

D. Welding of re-bars is not permitted. If necessary, use mechanical splicing device that provides 125% of the re-bar capacity.

E. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
   1. ACI 301, "Specification for Structural Concrete."
   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

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. 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.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Plain-Steel Wire: ASTM A 82, as drawn.

C. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

2.3 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

B. Joint Dowel Bars: Plain-steel bars, ASTM A 615/A 615M, Grade 60 (Grade 420). Cut bars true to length with ends square and free of burrs.

2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I.

B. Normal-weight Aggregate: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.
   1. For exposed exterior surface, do not use fine or course aggregates that contain substances that cause spalling. Normal maximum aggregate size is ¾ inch.

C. Water: Potable and complying with ASTM C 94.

Fly Ash: Not Permitted.

2.5 ADMIXTURES

A. General: Do not use admixtures containing calcium chloride.

B. Air-Entraining Admixture: ASTM C 260.
C. Water-Reducing Admixture: ASTM C 494, Type A.
D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.6 CURING MATERIALS

A. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
B. Water: Potable.

2.7 VAPOR RETARDERS

A. Vapor Retarder: ASTM E 1745, Class A, co-extruded polyolefin membrane, similar to Reef Industries Griffolyn 10 mil Green.

2.8 RELATED MATERIALS

A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
B. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.
C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
D. Extruded Polystyrene Filler Board: Rigid cellular insulation with closed cells and integral high density skin, having minimum compressive strength of 60psi as manufactured by DiversiFoam, Dow Chemical Company, or Owens Corning.
E. Nonmetallic Shrinkage-Resistant Grout: Premixed, factory- packaged, non-staining, noncorrosive nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
    1. Products: Subject to compliance with requirements, provide one of the following:
        a. Euco N-S Grout, Euclid Chemical Co.
        b. Five Star Grout, Five Star Products.
        c. Crystex, L&M Construction Chemicals, Inc.
        d. Masterflow 928 and 713, Master Builders Technologies, Inc.

2.9 REPAIR MATERIALS

A. Refer to paragraph 3.11 of this section.

2.10 CONCRETE MIXES

A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
    1. Proportion normal weight concrete according to ACI 211.2 and ACI 301.
B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
C. Slabs on grade and suspended slabs: Proportion normal weight concrete mix as follows:

1. Compressive Strength (28 Days): 4000 psi.

2. Calculated Equilibrium Unit Weight: 150 lb/cu. ft. plus or minus 3 lb/cu. ft. as determined by ASTM C 567.
3. Maximum Slump: 4 inches.
4. Maximum Water-Cementitious Materials Ratio: 0.48.

D. Exterior Slabs and Footings and Foundations Exposed to Frost:
1. Compressive Strength (28 Days): 4000 psi.
2. Calculated Equilibrium Unit Weight: 150 lb/cu. ft. plus or minus 3 lb/cu. ft. as determined by ASTM C 567.
3. Air Entrainment: 6%
4. Maximum Slump: 4 inches.
5. Maximum Water-Cementitious Materials Ratio: 0.48.

E. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 2 to 4 percent, unless otherwise indicated.

F. Do not air entrain concrete to trowel-finished interior floors and suspended slabs. Do not allow entrapped air content to exceed 3 percent.

G. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

H. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) 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 and concrete required to be watertight.

2.11 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

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 concrete 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.

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. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
   1. 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. Tool exterior corners and edges of permanently exposed concrete.

H. Form openings, chases, offsets, sinkages, keyways, 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 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.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork 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 provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

B. Leave formwork that supports weight of concrete in place until concrete has achieved the following:
   1. At least 70 percent of 28-day design compressive strength.

C. Determine compressive strength of in-place concrete by testing representative field- or laboratory-cured test specimens according to ACI 301.

D. 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.

E. 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.

3.4 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.

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.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric 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.

3.5 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 from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs: Form weakened-plane contraction joints, sectioning concrete into areas as indicated or if not indicated, not more than 200 square feet. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
   1. Grooved and Sawcut Joints: Form contraction joints after initial floating by light grooving. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces. Within 24 hours of finishing concrete, sawcut to a depth equal to 25% of the overall depth of the concrete.
   2. Contraction Joints in Supported Slabs: Sawcut joints 1/2” to 3/4” maximum depth.

D. Isolation Joints in Slabs: 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. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.
   1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 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. Distribute concrete throughout using wheel barrows, electric powered buggies or pumping methods. Coordinate admixtures to measure workability for concrete pumping operations.

D. 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, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

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 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. 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 or chemical accelerators, unless otherwise specified and approved in mix designs.

F. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R 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 FINISHING FLOORS AND SLABS

A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: 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.

1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish.

C. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
2. Finish and measure surface so gap at any point between concrete surface and an unleveled freestanding 10-foot long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:
   a. 1/8 inch.

D. Broom Finish: Apply a broom finish to exterior concrete and where ceramic or quarry tile will be bonded.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.8 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 Work.

B. Equipment Bases: Provide machine and equipment bases as shown on Drawings and required by Mechanical and Electrical Trades. Set anchor bolts for machines and equipment at correct elevations, complying with

diagrams or templates of manufacturer furnishing machines and equipment.

3.9 CONCRETE PROTECTION 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 recommendations in ACI 305R for hot-weather protection during curing.

B. Formed and Unformed Surfaces: Begin curing immediately after finishing concrete. Cure surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by:

1. 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.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

    b. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.

3.10 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

3.11 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas. Remove and replace concrete that cannot be repaired and patched to Architect's satisfaction.

B. 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 in any dimension in solid concrete but not less than 1 inch 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.

C. 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 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. Refer to Spec. Section 03 5300 Concrete Topping.
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 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 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 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix 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 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.

D. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.

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 one four sample set for each day's pour of each concrete mix, plus one set for each additional 10 cu. yd. (38 cu. m) or fraction thereof.
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 mix. Perform additional tests when concrete consistency appears to change.
3. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
    a. Cast and field cure one set of four standard cylinder specimens for each composite sample.
4. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.
    a. Test two field-cured specimens at 7 days and two at 28 days.
    b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.

C. 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.

D. Strength of each concrete mix 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.

E. 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 mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.

F. 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.

G. 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 or by other methods as directed by Architect. Additional testing shall be paid for by the contractor.

END OF SECTION 03 3000

SECTION 03 3500
CONCRETE FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Polished concrete finish.

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. Samples: Cured samples for each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS
A. Material certificates.
B. Product test reports.
C. Field quality-control reports.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer to apply products and methods employed on this project.
B. Mockups: Test an area of approximately 25 square feet to demonstrate aesthetic effects and set quality standards for materials and execution.

1.7 STORAGE AND PROTECTION:
A. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
B. Protect concrete slab.
   1. Protect new concrete from stains during construction.
   2. Clean concrete prior to polishing as reasonable and acceptable to Manufacturer.

1.8 PERFORMANCE REQUIREMENTS:

A. Provide polished flooring that has been selected, manufactured and installed to achieve the following:
B. Abrasion Resistance: ASTM C779, Method A, High resistance, no more than 0.008inch wear in 30 minutes.
C. Reflectivity: Increase of 35% as determined by standard gloss meter.
D. Waterproof Properties: Rilem Test Method 11.4, 70% or greater reduction in absorption.
E. High Traction Rating: NFSI 101-A, non-slip properties.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain color, grade, finish, type, and variety of product from single source with resources to provide products of consistent quality in appearance and physical properties.
B. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

2.2 POLISHED CONCRETE FINISHING PRODUCTS

A. Manufacturer: L & M Construction Chemicals, Inc.
B. Proprietary Products/Systems:
    1. Hardener, Sealer, Densifier: Proprietary, waterbased, odorless liquid, VOC compliant, environmentally safe chemical hardening solution leaving no surface film.
        a. Acceptable Material: L & M Construction Chemicals, Inc., FGS Hardener Plus.
    2. Joint Filler: Semi-rigid, 2-component, self-leveling, 100% solids, rapid curing, polyurea control joint and crack filler with Shore A 80 or higher hardness.
        a. Acceptable Material: L & M Construction Chemicals, Inc., Joint Tite 750.
    3. Oil Repellent Sealer: Ready to use, silane, siloxane and fluoropolymers blended water based solution sealer, quick drying, low-odor, oil and water repellent, VOC compliant with chemically hardened floors.
        a. Acceptable Material: L & M Construction Chemicals, Inc., Petrotex.
    4. Cleaning Solution: Proprietary, mild, highly concentrater liquid concrete cleaner and conditioner containing wetting and emulsifying agents; biodegradable, environmentally safe and certified High Traction by National Floor Safety Institute (NFSI).
        a. Acceptable Material: L & M Construction Chemicals, Inc., FGS Concrete Conditioner.
    5. Finish: Medium gloss (MG-2), 800 grit.
    6. Color: Natural Concrete.

2.3 MIXES

A. General: Mix products, in clean containers, according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Perform surveys as the Work progresses to detect hazards resulting from concrete-maintenance work.

B. Verify that concrete substrate conditions, are acceptable for polishing in accordance with manufacturer's instructions prior to installation of concrete finishing materials.

3.2 PREPARATION

A. Ensure that supervisory personnel are on-site and on duty when concrete maintenance work begins and during its progress.

B. Protect surrounding surfaces of building from harm resulting from concrete polishing work.
   1. Comply with manufacturer's written instructions for protections and precautions.
   2. Contain dust and debris generated by concrete polishing work and prevent it from reaching adjacent surfaces.
   3. Protect floors and other surfaces along haul routes from damage, wear, and staining.
   4. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.

C. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is in working order.
   1. Prevent solids such as aggregate or mortar residue from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from concrete maintenance work.
   2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

D. Preparation for Polishing:
   1. Ensure surfaces are clean and free of dirt and other foreign matter harmful to performance of concrete finishing materials.
   2. Examine surface to determine soundness of concrete for polishing. Remove surface contamination.

3.3 APPLICATION

A. General: Comply with manufacturer's written instructions and recommendations for application of products, including surface preparation.

B. Floor Surfacing Polishing and Treatment:
   1. Provide polished concrete floor treatment in entirety of slab indicated by drawings. Provide consistent finish in all contiguous areas.
   2. Apply floor finish prior to installation of fixtures and accessories.

3. Diamond polish concrete floor surfaces with power disc machine recommended by floor finish manufacturer. Sequence with coarse to fine grit using dry method.
    a. Comply with manufacturer's recommended polishing grits for each sequence to achieve desired finish level. Level of sheen shall match that of approved mock-up.
    b. Expose aggregate in concrete surface only as determined by approved mock-up.
    c. All concrete surfaces shall be as uniform in appearance as possible.
4. Apply FGS Hardener Plus, Hardener, Densifier As Follows:
    a. First coat at 250 ft2/gal.
    b. Second coat at 350 ft2/gal.
    c. Follow manufacturer's recommendations for drying time between successive coats.
5. Remove defects and repolish defective areas.
6. Finish edges of floor finish adjoining other materials in a clean and sharp manner.

3.4 ADJUSTMENTS

A. Polish to higher gloss those areas not meeting specified gloss levels per mock-up.

3.5 FINAL CLEANING

A. Mechanically scrub treated floors for seven days with soft to medium pads with approved cleaning solution.
B. Upon completion, remove surplus and excess materials, rubbish, tools and equipment.

3.6 PROTECTION

A. Protect installed product from damage during construction.

END OF SECTION 03 3500

SECTION 034500
ARCHITECTURAL PRECAST CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.2 DESCRIPTION OF WORK

A. Extent of architectural precast concrete is shown on drawings.
B. Types of architectural precast concrete applications required include the following:
   1. Precast concrete shapes anchored by structural steel frame.
C. Related Work Specified Elsewhere:
   1. Cast-in-place concrete: Section 033000.
   2. Unit masonry: Section 042000.
   3. Metal fabrication: Section 055000.
   4. Joint sealers: Section 079200.

1.3 SYSTEM PERFORMANCE REQUIREMENTS:

A. General: Provide fabricator's architectural precast concrete adapted to the application indicated that comply with performance requirements specified and with applicable requirements of Building Code.
B. Structural Performance: Design, engineer, fabricate and install architectural precast concrete including anchoring and support to withstand wind, gravity and other loads; to withstand building movement and accommodate deflections due to thermal variation, loading or other causes; and to resist in-service use conditions that architectural precast concrete units will experience including exposure to weather. Establish design of steel reinforcing, concrete mixes and connections for loads and stresses as required.
C. Design and Engineering Responsibility: Manufacturer/Fabricator shall assume undivided responsibility for design and engineering architectural precast concrete units and connections including employing a Registered Professional Engineer specializing in structures licensed in the State of Michigan to prepare complete design calculation, shop drawings and other structural documentations.

1.4 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the following codes, specification and standard, except as otherwise indicated:
   1. ACI 301 "Specifications for Structural Concrete for Buildings".
   2. ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete".
   3. ACI 311 "Recommended Practice for Concrete Inspection".
   4. ACI 315 "Manual of Standard Practice for Detailing Reinforcing Concrete Structures".
   5. ACI 318 "Building Code Requirements for Reinforced Concrete".
   6. ACI 347 "Recommended Practice for Concrete Formwork".

7. ACI 503R “Use of Epoxy Compounds with Concrete”.
8. ACI 548.1R “Guide for the Use of Polymers in Concrete”’
9. CRSI “Manual of Standard Practice”.
10. PCI MNL 116 “Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products”.
11. PCI MNL 117 “Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products”.
12. PCI MNL 120 “Design Handbook – Precast and Prestressed Concrete.”
13. PCI MNL 122 “Architectural Precast Concrete”.

B. Fabricator Qualifications: Firm with not less than five years successful experience in fabrication of architectural precast concrete units similar to those required for this project with record of successful in-service performance and with sufficient production capacity to produce required units without delaying the work.
   1. Fabricator must be producer member of Precast/Prestressed Concrete Institute (PCI) and be designated a PCI Certified Plant for Product Group A, Category A1.

C. Professional Engineer Qualifications: A professional engineer legally authorized to practice in the jurisdiction where Project is located and experienced in providing engineering services of the kind indicated that have resulted in the installation and successful in-service performance of architectural precast concrete units similar to this Project in material, design and extent.

D. Erector Qualifications: Minimum of five years successful experience in erection of architectural precast concrete units similar to those required for this project and with record of successful in-service performance.

E. Design concept modification may be made only as necessary for field conditions, to ensure proper fitting of the work and to comply with design requirements as acceptable to the Architect. Maintain general design concept shown without increasing or decreasing member sizes and modules or altering pattern configurations shown.

F. Welding Standards: Comply with applicable provisions of AWS D 1.1 “Structural Welding Code – Steel” and AWS D 1.4 “Structural Welding Code – Reinforcing Steel”.
   1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 SUBMITTALS

A. Product Data: Submit fabricator’s specifications, data and instructions for manufactured materials and products. Include mix designs, certification and laboratory test reports as required.
   1. Include water absorption test reports for units with exterior exposure.

B. Shop Drawings: Submit shop drawings prepared under supervision of Registered Professional Engineer showing complete information for fabrication and installation of architectural precast concrete units. Indicate member dimensions and cross-sections; fabrication tolerances; location, size and type of reinforcement including special reinforcements; architectural concrete facing including surface patterns, details of patterns, wrap around edge treatment and extent of finish; and lifting devices necessary for handling and erection.
   1. Indicate separate face and back-up mix locations, if any, and thicknesses.

2. Provide layout, dimensions and identification of each precast unit corresponding to sequence and procedure of installation. Indicate welded connections by AWS standard symbols. Detail loose, cast-in and field hardware, inserts, connections and joints including accessories and construction at openings in architectural precast concrete units.
3. Indicate location and details of anchorage devices that are to be embedded in other construction. Furnish templates if required for accurate placements.
4. Provide complete design calculations prepared by a Registered Professional Engineer licensed in the State of Michigan.

C. Samples for Verification Purposes: Submit samples of architectural concrete facing approximately 24 inches square by two inches thick to illustrate quality, patterns, color and texture of surface finish. Where normal color and texture variations are to be expected, include two or more units in each set of samples showing limits of such variations.

D. Design Mixes: Submit design mix for each concrete mix, and revised mix proportions when characteristics of materials, project conditions, weather, test results or other circumstances warrant adjustments.

E. Welder Certificates: Submit welder certificates signed by Contractor certifying that welders comply with specified AWS “Qualification” requirements.

F. Material Test Reports: Submit material test reports from a qualified independent testing agency evidencing compliance with specified requirements for the following based on comprehensive testing of current materials:
1. Concrete materials.
2. Reinforcing materials.
3. Admixtures.
4. Bearing Pads.
5. Anchorage and support materials.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver architectural precast concrete units to project site in such quantities and at such times to assure continuity of installation. Store and handle units at project site to prevent cracking, distortion, warping, staining and other physical damage and so that markings are visible.

B. Lift and support units only at designated lifting and supporting points as shown on final shop drawings.

C. Deliver anchorage items that are to be embedded in other construction before starting such work. Provide setting diagrams, templates, instructions and directions as required for installation.

PART 2 - PRODUCTS

2.1 FORMWORK

A. Provide forms and, where required, form facing materials of metal, plastic, wood or other acceptable material that is non-reactive with concrete and will product required finish surfaces.

B. Accurately construct forms to be mortar tight of sufficient strength to withstand pressures due to concrete placing operations, temperature changes and for prestressing, pretensioning and detensioning operations. Maintain formwork to

provide completed precast concrete units of shapes, lines and dimensions indicated within fabrication tolerances specified in PCL MNL 117.

C. Design forms so that stresses are not induced in precast units when forms are stripped prior to detensioning due to deformation of concrete under prestress or movement during detensioning.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Welded Wire Fabric: ASTM A 185.

C. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing.

1. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2) except provide only stainless steel when architectural facing.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III.

1. Use only one brand, type, and source of supply of cement throughout the project, unless otherwise acceptable to Architect.
2. Cement must produce exposed to view color acceptable to Architect.

B. Aggregates:

1. General: ASTM C 33 with coarse aggregates complying with Class 5S requirements. Provide each type of aggregate used from a single source.
    a. Local aggregates not complying with ASTM C 33, but which have shown special test or actual service to produce precast concrete of adequate strength and durability may be used when acceptable to Architect.
    b. Do not use aggregates containing soluble salts or other substances such as iron sulphides, pyrite, marcasite or ochre which can cause stains on exposed precast surfaces.
2. Fine Aggregates: Clean, sharp, natural sand free from loan, clay lumps or other deleterious substances.
    a. For architectural concrete facing mix use aggregate to provide appearance matching reference samples as acceptable to Architect.
3. Coarse Aggregates: Clean, uncoated, processed, aggregate containing no clay, mud, loan, or foreign matter.
    a. For architectural concrete facing mix use aggregate to provide appearance matching reference samples as acceptable to Architect.

C. Pigments: Nonfading, resistant to lime and other alkalies, and types as required to provide appearance matching reference samples as acceptable to Architect.

D. Water: Potable, free of deleterious materials that may affect color stability, setting or strength to be harmful to embedded steel.

E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

F. Water-Reducing, Retarding, or Accelerating Admixtures: ASTM C 494. Type as selected by Fabricator. Use only products by same manufacturer for each mix design and establish their compatibility.

G. Calcium chloride or admixtures containing more than 0.1 percent chloride ions are not permitted.
H. Bonding Agent and Anti-Corrosion Coating: Commercially formulated epoxy modified cementitious product which is both a bonding agent and provides anti-corrosion protection.
   1. Product/Manufacturer: Sika Armatec 110 EpoCem; Sika Corp.

2.4 CONNECTION MATERIALS

A. Steel Shapes and Plates: ASTM A 36.
B. Carbon Steel Plates: Structural quality, hot-rolled carbon steel, ASTM A 283, Grade C.
C. Carbon Steel Bolts and Studs: ASTM A 307, Grade A, regular low-carbon steel, hexagon head bolts and studs, nuts and flat, unhardened steel washers.
D. High-Strength Threaded Fasteners: ASTM A 325, Type 1, heavy hexagon structural bolts, heavy hexagon nuts and hardened washers, quenched and tempered medium-carbon steel.
E. Welded Headed Studs: AWS D 1.1, Type B headed studs, cold finished carbon steel bars.
F. Welding Electrodes: Comply with AWS standards.
G. Accessories: Provide clips, hangers, plastic shims and other accessories required to install project units and to support subsequent construction or finishes.
H. Hot-Dip Galvanized Finish: Apply zinc coating by hot-dip process, complying with the following requirements:
   1. ASTM A 123 for galvanizing rolled, pressed and forges shapes, plates, bars and strips.
   2. ASTM A 153 for galvanizing iron and steel hardware
I. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

2.5 BEARING PADS

A. Provide bearing pads as follows and as required by design:
   1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore A durometer, minimum 2250 psi tensile strength as determined by ASTM D 412.
   2. Random, Fiber Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer, 70 to 90 Shore A durometer surface hardness.
   3. Frictionless Pads: Tetraflouroethylene (TFE), glass fiber reinforced, bonded to mild steel plate, type required for in-service stress.

2.6 ANCHORING MATERIALS

A. Provide dowels, anchors and attachments of types and sizes shown or required to support precast concrete and fabricated from stainless steel, ASTM A 666, AISI Type 304, temper as required to support loads imposed without exceeding allowable design stresses, for anchors in direct contact with precast concrete and the fasteners connecting them to other anchors and to building structure.

2.7 GROUT MATERIALS

A. Cement Grout: Portland cement, ASTM C 150, Type 1, and clean, natural sand, ASTM C 404. Mix at ratio for 1.0 part cement to 3.0 parts sand, by volume, with minimum water required for placement and hydration.

2.8 CONCRETE REPAIR MATERIALS

A. Epoxy Adhesive: ASTM C 881, two component high strength low viscosity resin adhesive suitable for crack repair.
   1. Products: Subject to compliance with requirements, provide only the following:
      a. Sikadur 35 Hi-Mod LV LPL: Sika Corp.

B. Bonding Agent and Admixture: Acrylic polymer latex, non-reemulsifiable.
   1. Products: Subject to compliance with requirements, provide only the following:
      a. SikaLatex: Sika Corp.

C. Patching Compound: Single component, factory packaged with graded aggregates and selected cements for use with specified admixture.
   1. Products: Subject to compliance with requirements, provide only the following:
      a. SikaRepair SHB: Sika Corp.

2.9 MISCELLANEOUS MATERIALS

A. Setting Buttons: Lead or resilient plastic buttons, non-staining to precast concrete, sized to suit joint thickness and bed depths of precast concrete, sized to suit joint thickness and bed depths of precast concrete involved without intruding into required depths of joint sealants or causing third-side adhesion between sealant and setting button.

2.10 MIX PROPORTION AND DESIGN

A. Prepare design mixes for each type of concrete required.

B. Design Mixes may be prepared by independent testing facility or by qualified precast manufacturing plant personnel at precast fabricator's option.

C. Proportion mixes by either laboratory trial batch or field experience methods using materials to be employed on the project for each type of concrete required complying with ACI 318.

D. Exposed Architectural Concrete Facing Mix: Standard weight concrete consisting of specified Portland Cement, fine and coarse aggregates, admixtures and water to product the following properties:
   1. Compressive Strength: 5,000 psi minimum at 28 days.
   2. Total Air Content: Not less than 4 percent nor more than 6 percent.
   3. Appearance: Use Portland Cement, pigment, coarse and fine aggregate which will match reference samples as acceptable to Architect.
   4. Cure compression test cylinders using same methods as used for precast concrete work.

E. Backup Mix: Standard weight concrete consisting of specified Portland Cement, aggregates, admixtures and water to product the following properties:
   1. Compressive Strength: 5,000 psi minimum at 28 days.

2. Release Strength: 3,500 psi.
3. Total Air Content: Not less than 4 percent nor more than 6 percent.
4. Cure compression test cylinders using same methods as used for precast concrete work.

F. Submit written reports to Architect for proposed mix for each of concrete at least 15 days prior to start of precast unit production. Do not begin concrete production until mixes and evaluations haven been reviewed by Architect.

G. Adjustment to Concrete Mixes: Mix design adjustments may be requested when characteristics of materials, job conditions, weather, test results or other circumstances warrant. Laboratory test data for revised mix designs and strength results must be submitted to and accepted by Architect before using in the work.

H. Admixtures: Use air-entraining admixture in concrete unless otherwise indicated.
1. Use water-reducing admixtures in strict compliance with manufacturer's directions. Admixtures to increase cement dispersion, or provide increased workability for low-slump concrete may be used subject to Architect's acceptance.
2. Use amounts as recommended by admixture manufacturer for climatic conditions prevailing at the time of casting. Adjust quantities of admixtures as required to maintain quality control.

2.11 FABRICATION

A. General: Fabricate architectural precast concrete units complying with manufacturing and testing procedures, quality control recommendations and dimensional tolerances of PCI MNL 117 and in this section.

B. Form work: Accurately construct forms mortar-tight and of sufficient strength to withstand pressures due to concrete placing operations, temperature changes, and for pretensioning and detensioning operations. Maintain formwork to provide completed precast concrete units of shapes, lines and dimensions indicated, within fabrication tolerances specified in PCI MNL 117 and in this section.
1. Coat surface of forms with bond-breaking compound before reinforcement is placed. Provide commercial formula form-coating compounds that will not bond with, stain or adversely affect concrete surfaces, and that will not impair subsequent treatments of concrete surfaces requiring bond or adhesion. Apply in compliance with manufacturer's instruction.
2. Unless for prestressed units are stripped prior to detensioning, design forms so that stresses are not induced in precast units due to deformation of concrete under prestress or movement during detensioning.

C. Built-In Anchorages: Accurately position built-in anchorage devices and secure to formwork. Locate anchorages where they do not affect the position of the main reinforcement or placing of concrete. Do not relocate bearing plates in units unless acceptable to Architect.
1. Wrap edges of all embedded plates with thin layer of resilient material such as preformed foam sealant as required to prevent spalling of concrete at edges under localized conditions of high temperature such as welding.

D. Cast-in reglets, slots, holes and other accessories in units to receive cramps, dowels, reglets, flashings and other similar work as indicated.
E. Supply loose steel plates, clip angles, seat angles, anchors, dowels, cramps and other miscellaneous steel shapes not provided by other trades, necessary for securing architectural precast concrete units to supporting and adjacent members.
F. Cast in openings larger than 10 inches in any dimension according to final shop drawings. Other smaller holes may be field cut by trades requiring them as acceptable to Architect.
G. Reinforcement: Comply with recommendation of CRSI's "Manual of Standard Practice" for fabricating, placing and supporting reinforcement.
   1. Clean reinforcement of loose rust and mill scale, earth and other materials that reduce or destroy bond with concrete.
   2. Accurately position, support and secure reinforcement against displacement by formwork, construction or concrete placement operations. Locate and support reinforcement by metal chairs, runners, bolsters, spacers and hangers as required.
   3. Place reinforcement to obtain not less than minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
   4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace sides with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
H. Reinforce architectural precast concrete units to resist stresses resulting from handling, transportation, erection and in-service conditions and to minimize cracking. Provide 200 psi minimum prestress after all losses unless otherwise acceptable to Structural Engineer and Architect.
I. Concrete Mixing: Comply with requirements and with ASTM C 94. Additionally comply with PCI MNL 117 for architectural concrete face mix. No additional water may be added following concrete batching.
J. Concrete Placement: Place concrete in a continuous operation to prevent seams or planes of weakness from forming in architectural precast concrete units. Comply with requirements of ACI 304R for measuring, mixing, transporting and placing concrete.
   1. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with ACI 309R.
   2. Comply with ACI 306R procedure for cold weather concrete placement.
   3. Comply with ACI 305R procedures for hot weather concrete placement.
K. Identify pick-up points and orientation in structure with permanent markings, complying with markings indicated on final shop drawings. Imprint cast date on each precast unit on a surface that will not show in finished structure.
L. Cure by low-pressure steam, steam vapor, radiant heat and moisture, or another similar process to accelerate concrete hardening and to reduce curing time according to requirements of PCI MCL 117.
M. Fabricate architectural precast units straight, smooth, and true to size and shape, with exposed edges and corners precise and square unless otherwise indicated.

1. Precast units which are warped, cracked, broken, spalled, stained or otherwise defective will not be acceptable.

N. Surface Finish: Fabricate precast units and provide exposed surface finishes as follows:
   1. Exposed Architectural Concrete Finish: Match existing.
   2. Other Surfaces: Normal plant run finish produced in forms that import a smooth finish to concrete. Small surface holes caused by air bubbles, normal color variations, form joint marks and minor chips and spalls will be tolerated. Major or unsightly imperfections, honeycomb or structural defects will not be permitted.

O. Where ends of strands will not be enclosed or covered, cut flush and cover with specified bonding agent and anti-corrosion coating as recommended by manufacturer.

P. Dimensional Tolerances of Finished Units: Overall height and width measured at face adjacent to mold at time of casting:
   1. 10 feet or less: Plus or minus 1/8 inch.
   2. 10 feet to 20 feet: Plus 1/8 inch, minus 3/16 inch.
   3. Angular deviation of plan of side mold: 1/32 inch per 3 inches depth, or 1/16 inch total, whichever is greater.
   4. Openings within one unit: Plus or minus ¼ inch.
   5. Out of square (difference in length of two diagonal measurements): 1/8 inch per 6 feet or ¼ inch total, whichever is greater.
   6. Thickness: Minus 1/8 inch, plus ¼ inch.
   7. Tolerances of other dimensions not otherwise indicated: Numerically greater of plus or minus 1/16 inch per 10 feet or plus or minus 1/8 inch.

Q. Position Tolerances: For cast-in items measured from datum line locations as shown on reviewed shop drawings:
   1. Anchors and Inserts: Within 3/8 inch of centerline location.
   2. Blockouts and Reinforcements: Within ¼ inch of position as shown on shop drawings, where such positions have structural implications or affect concrete cover; otherwise within plus or minus ½ inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structure and conditions under which architectural precast concrete units are to be erected. Notify General Contractor in writing of conditions detrimental to proper and timely completion of the work. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 INSTALLATION

A. Deliver anchorage items which are to be embedded in other construction before start of such work. Provide setting diagrams, templates, instructions and directions as required for installation.

B. Do not install architectural precast concrete units until concrete has attained its design compressive strength.

C. Install clips, hangers and other accessories required for connecting architectural precast concrete units to supporting members and back-up materials.

D. Install bearing pads as architectural precast concrete units are being erected. Set pads on true, level and uniform bearing surfaces and maintain in correct position until structural precast concrete units are placed.
   1. Use elastomeric bearing pads not less than ½ inch thick by 5 inches wide where precast members bear on structural steel.
   2. Set all bearing pads not less than ¾ inch back from edge of supported and supporting members.
      a. Glue pads in position to maintain location during erection.
E. Lift, place and secure architectural precast units in accordance with manufacturer's printed instructions and final shop drawings. Keep units tights and perpendicular to bearing supports. Do not install architectural precast units until supporting members are in place and secured.
F. Install architectural precast concrete members plumb, level and in alignment within PCI MNL 117 and specified limits of erection tolerances. Provide temporary supports and bracing as required to maintain position, stability and alignment as members are being permanently supported and anchored.
   1. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
   2. Jack and reposition bearing pads prior to final connection being made if pads shift during erection.
G. Anchor architectural precast units in final position by bolting, welding, grouting or as otherwise indicated. Remove temporary shims, wedges and spacers as soon as possible after anchoring is completed.
H. Welding: Perform welding in compliance with AWS D 1.1 and AWS D 1.4 with qualified welders.
   1. Protect architectural precast concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
   2. Repair damaged steel surfaces by applying galvanizing repair coating.
I. At bolted connections use lock washers or other acceptable means to prevent loosening of nuts.
J. Do not use powder actuated fasteners for attaching accessory items to precast concrete surfaces.
K. Do not cut reinforcing or prestressing strands without approval of manufacturer.
L. Grout connections and joints where required or indicated including open spaces at keyways, connections and joints. Retain grout in place until sufficiently hard to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, plumb and level with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.

3.3 ERECTION TOLERANCES

A. Warpage: Fabricate and install wall panels so that each panel after erection complies with the following dimensional requirements:
   1. Bowing (concave or convex) of any part of a flat surface not to exceed length of bow/360 with a maximum of ¾ inch up to 30 feet.

2. Maximum warpage of one corner out of plane of other three; the greater of 1/6 inch per foot distance from the nearest adjacent corner, or 1/8 inch.

B. Tolerances for Location of Precast Units: Fabricate and erect precast units so that joints between panels meet the following:
   1. Face width of joints: Plus or minus 3/16 inch.
   2. Joint taper: ¼ inch per foot length, with maximum length of tapering in one direction of 10 feet
   3. Step in face: ¼ inch
   4. Jog in alignment of edge: ¼ inch
   5. Alignment for exterior panels is outside face.
   6. Variation from plumb: Plus or minus ½ inch in any 40 foot run.
   7. Variation from level: Plus or minus ¼ inch in any 40 feet run.

3.4 REPAIRS

A. Repair exposed to view architectural precast concrete unit surfaces to match color, texture and uniformity of surrounding concrete when permitted by Architect.

B. Crack Repair: Use only specified epoxy adhesive repair material, and comply with manufacturer's instructions for mixing and injecting epoxy. Install injection ports, surface sealers and other required preparation. After epoxy has cured remove ports, surface sealers, and any other exposed preparations. Provide finish surface flush with adjacent precast concrete with same color and texture. Patch as required.

C. Spall Repair: Use only specified patching compound and bonding agent and admixtures. Comply with manufacturer's instructions for mixing, preparations and application.
   1. Trim edges and spalled areas to provide not less than 1/2 inch depth at approximately right angle to surface. Do not feather edges. Maintain straight perimeter edges whenever possible, and configure patched areas in compact, contiguous rectilinear shapes.
   2. Prepare entire area where patching required to remove contaminants, loosely bonded aggregate and to expose sound concrete surface. Use wire brushes, compressed air and abrasive or water blasting procedures as necessary.
   3. Mix and apply patching compound and admixture as recommended by manufacturer. Trowel apply as required to match adjacent texture and configuration to provide flush surfaces in true planes and sharp, straight edges aligning with adjacent surfaces.
   4. Fill repair areas with patching compound, and do not feather edges. Finish patched areas to match texture of and be flush with adjacent concrete surfaces except where architecturally exposed finish.

D. Surface Repair Where Architecturally Exposed Finish: Thoroughly clean, dampen with water and brush-coat area to be repaired with specified bonding agent. Place job mixed patching mortar using same mix as for exposed architectural finish before bonding compound has dried.
   1. Mix and apply dry-pack mortar using only enough water as required for handling and placing. Do not feather edges. Compact mortar in place. Strike-off slightly higher than surrounding surface and apply finish as required to

match adjacent texture and configuration to provide flush surfaces in true planes and sharp, straight edges aligning with adjacent surfaces.
2. Protect concrete mortar from premature drying and excessive cold or hot temperatures. Cure concrete mortar after placing and finishing, keeping continuously moist for not less than 7 days.

E. Remove and replace damaged architectural precast concrete units when repairs do not meet requirements.
1. Limitations as to amount of patching which will be permitted is subject to acceptance of Architect.

3.5 CLEANING

A. Clean exposed surfaces after erection to remove weld marks, other markings, dirt and stains.
1. Wash and rinse in accordance with precast manufacturer's recommendations. Protect other work from damage due to cleaning operations.
2. Do not use cleaning materials or processes which could change the character of exposed precast finishes.

3.6 ACCEPTANCE REQUIREMENTS

A. Conduct inspections, perform testing and make repairs or replace unsatisfactory architectural precast concrete units as required.
B. In addition to above, in-place architectural precast concrete units may be rejected for any of the following:
1. Exceeding specified installation tolerances.
2. Damage during construction operations.
3. Exposed-to-view surfaces which develop surface finish deficiencies including cracking.
4. Other appearance defects as listed in PCI MNL 117.

END OF SECTION 03 4500

SECTION 03 5300
CONCRETE TOPPING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Leveling fill coat of existing entrance floor mat recess to receive new walk off carpet flooring.

1.3. QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who is acceptable to floor topping manufacturer, who has completed floor topping applications similar in material and extent to that required for this Project, and whose work has resulted in construction with a record of successful in-service performance.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for floor topping materials including primers and sealers.

B. Qualification Data: Submit written information to establish qualifications, demonstrating capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners.

1.5 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, mixing with other components, and application.

B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written recommendations for substrate temperature and moisture content, ambient temperature and humidity, ventilation and other conditions affecting floor topping performance.

B. Close areas to traffic during floor topping application and for time period after application recommended in writing by manufacturer.

C. Protect adjacent finish materials against spatter during topping placement.

1.7 COORDINATION

A. Coordinate floor topping with requirements of finish flooring products including adhesives.

1. Before installing surface sealers recommended by floor topping manufacturer, verify compatibility with finish flooring installation adhesives.

PART 2 – PRODUCTS

2.1 TOPPING MATERIAL FOR INFILL:

A. Floor Topping: Cement based, self-leveling product formulated for applications ranging in thickness from feather edge to several inches which will achieve not less than 4,500 psi compressive strength at 28 days and recommended by manufacturer as a wearing surface.
   1. Products: Subject to compliance with requirements, provide only one of the following:
      a. Thin Patch; Tamms Industries, Inc.
      b. Approved Equivalent by Euclid Chemical Co. or Sika Chemical Co.

B. Water: Potable within temperature range recommended by floor topping manufacturer.

C. Reinforcement: Fiber reinforce with collated, fibrillated, polypropylene fibrous reinforcing material per manufacturer's written instructions.

D. Primer: Product of floor topping manufacturer recommended in writing for substrate, conditions and applications indicated.

2.2 RELATED MATERIALS

A. Curing Materials: Absorptive cover, moisture retaining cover of similar materials as recommended by floor topping manufacturer.

B. Sealer: Aqueous solution of sodium silicate with nonacid penetrating agent, reacting chemically with free lime in topping to form a hard, nondusting surface which will not inhibit bonding with future finishes.
   1. Use only products recommended by floor topping manufacturer which are compatible with floor finishes to be applied.

2.3 MIXING

A. Topping Mix: Use materials in proportions and mix in accordance with manufacturer's written instructions.
   1. Add fine and/or coarse aggregate for application thickness as recommended by floor topping manufacturer.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which floor topping is to be installed. Notify Construction Manager in writing of conditions detrimental to timely and proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 PREPARATION

A. General: Prepare and clean substrate according to floor topping manufacturer's written instructions for substrate indicated. Provide clean, dry, neutral-pH substrate for floor topping application.
   1. Treat nonmoving substrate cracks to prevent cracks from telegraphing (reflecting) through floor topping according to manufacturer's written recommendations.
   2. Fill substrate voids to prevent floor topping from leaking.

B. Mechanically remove laitance, glaze, efflorescence, curing compounds, dust, dirt, grease, oil and other contaminants that might impair floor topping bond according to floor topping manufacturer's written instructions.
   1. Clean entire surface of area to receive floor topping using wire brushes, acid etching, compressed air, sandblasting, waterblasting or other means as required to remove contaminants and provide acceptable bonding substrate.

C. Adhesion Tests: After substrate preparation, test substrate for adhesion with floor topping according to manufacturer's written instructions.

D. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

3.3 TOPPING PLACEMENT

A. Apply floor topping in compliance with manufacturer's written instructions.
   1. Coordinate application of components to provide optimum floor topping-to-substrate and intercoat adhesion.
   2. At substrate expansion, isolation and other moving joints, allow joint of same width to continue through floor topping.

B. Apply floor topping to produce uniform, level surface. Apply a final layer without aggregate if required to produce smooth surface. Feather edges to match adjacent floor elevations. Maximum acceptable slope of feathered surfaces is 1/8 inch per foot.

C. Where required thickness exceeds recommendations of manufacturer, provide material in lifts of recommended thickness.

3.4 CURING AND PROTECTION

A. Protect freshly placed topping from premature drying and excessive cold or hot temperatures.

B. Cure topping according to manufacturer's written instructions. Prevent contamination during application and curing processes.

C. Protect topping from physical damage or reduced strength due to weather extremes during mixing, placement and curing.

D. Protect topping from concentrated and rolling loads for remainder of construction period.

E. Remove and replace topping areas that evidence lack of bond with substrate, including areas which evidence a "hollow" sound when tapped.

F. Do not install finish flooring over topping until after time period recommended by floor topping manufacturer.

END OF SECTION 03 5300

SECTION 04 2000
UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES
A. Concrete masonry units (General).
B. Concrete masonry units (Decorative).
C. Reinforcement, anchorage, and accessories.
D. Installation of salvaged brick for patching of existing brick walls.
E. Brick cleaning.

1.4 REFERENCES
A. ANSI/ASTM A82 - Cold-Drawn Steel Wire for Concrete Reinforcement.
B. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
C. ASTM A525 - Steel Sheet, Zinc Coated, (Galvanized) by the Hot-Dip Process.
D. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
E. ASTM C129 - Non-Load Bearing Concrete Masonry Units.
F. ASTM C145 - Solid Load Bearing Concrete Masonry Units.
G. IMIAC - International Masonry Industry All-Weather Council: Recommended Practices and Guide Specification for Cold Weather Masonry Construction.
H. UL - Underwriters' Laboratories.
I. Building Code Requirements for Masonry Structures, ACI 530 and ASCE 5.
J. Specifications for Masonry Structures, ACI 530.1 and ASCE 6.

1.5 SUBMITTALS
A. Submit Product Data for all masonry units and fabricated wire reinforcement.
B. Submit test data on all masonry units used on project; ie:
   1. Compressive strength.
   2. Water absorption.
   3. Saturation coefficient.
C. Mix Design: Furnish description of mortar and grout components, proportions, and twenty-eight (28) day compressive strengths.

1.6 QUALIFICATIONS
A. Installer: Company specializing in performing the work of this Section with minimum five years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site.
B. Store and protect products.
C. Accept masonry units on site. Inspect for damage.

1.9 ENVIRONMENTAL REQUIREMENTS
A. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.
B. Cold Weather Requirements: IMIAC - Recommended Practices and Specifications for Cold Weather Masonry Construction.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SUPPLIERS - (CONCRETE MASONRY UNITS) ARE:

A. Best Block Co.
B. Fendt Builders Supply, Inc.
C. Grand Blanc Cement Products, Inc.
D. VPB Architectural Products, Inc.
E. Tri-County Block and Brick.

2.2 CONCRETE MASONRY UNITS (GENERAL)

A. Hollow Load Bearing Block Units: ASTM C90, Grade N, Type I - Moisture Controlled; normal weight.
B. Hollow or Solid Non-Load Bearing Block Units: ASTM C129, Type I - Moisture Controlled; normal weight.
C. Masonry Units: Nominal modular size of 8 x 8 x 16 inches unless noted or required otherwise. Provide special units for 90-degree corners, bond beams, lintels and all other required special shapes.
D. Minimum Compressive Strength: All concrete masonry units shall have a "Net Area Compressive Strength" of 1900 psi, minimum.

2.3 CONCRETE MASONRY UNITS (DECORATIVE)

A. Ground Face Units - Design Standard:
   1. Manufacturer: Grand Blanc Cement Products
   2. Texture: Manufacturer's standard ground face smooth texture.
   3. Integral Colors:
      a. CMU-1 (field color): Irish Gold.
      b. CMU-2 (accent striping): Desert Blend.

2.4 CAVITY INSULATION

A. Rigid cellular polystyrene thermal insulation with closed cells and high density skin, in manufacturer's standard sizes complying with the following:
   1. FS HH-524C and ASTM C 578
   2. Type IV, 1.6 pcf min. density.
   3. Aged R-value of 5.4 and 5.0 at 40 and 75 degrees respectively.
   4. Minimum compressive strength of 25psi per ASTM D 1621.
B. Acceptable manufacturers subject to compliance with requirements:
   1. Amoco Foam Products Inc.
   2. Dow Chemical Co.
   3. UC Industries

2.5 REINFORCEMENT AND ANCHORAGE

A. Single Wythe Joint Reinforcement: Truss type; hot dip galvanized after fabrication cold-drawn steel conforming to ANSI/ASTM A82, 9 gauge side rods with 9 gauge cross ties; as manufactured by AA Wire Products Co., Dur-O-Wall, Hohman & Barnard, or an approved equivalent.
B. Multiple Wythe Joint Reinforcement: Ladder type; without moisture drip; hot dip galvanized after fabrication cold-drawn steel conforming to ANSI/ASTM A82, 3/16 inch side rods with 3/16 inch cross ties; as manufactured by AA Wire Products Co., Dur-O-Wall, Hohman & Barnard, or an approved equivalent.
C. Reinforcing Steel: Deformed type; As Indicated on the Construction Drawings, unprotected finish, complying with ASTM A615 Grade 60.
D. Strap Anchors: Flat bent steel shape, 1-1/4 inches x length required, galvanized ASTM A123, G90 finish.
E. Adjustable (2-piece) tab design with single pair of side rods, perpendicular cross

rods spaced not more than 16 inches o.c. and rectangular open end box-type ties with eyes, spaced not more that 16 inches o.c., with side rods spaced for embedment within each face shell of back-up wythe and with separate open end box-type adjustable ties with lintels engaging the cross tie eyes and extended to engage the outer wythe by at least 1 ½ inches and apaced not more than 16 inches o.c.

1. Design Standard: Hohman & Barnard adjustable Eye-Wire Ladder Type #270.

2.6 ACCESSORIES

A. Preformed Control Joints: Neoprene material. Provide with corner and tee accessories, heat fused joints, as manufactured by AA Wire Products Co., Dur-O-Wall, Hohmann & Barnard, or other approved equivalent.
B. Joint Filler: Closed cell polyvinylchloride; foam; oversized 50 percent to joint width; compressible; self-expanding; use maximum lengths; "Will-Seal" as manufactured by Illbruck.
C. Nailing Strips: Softwood, preservative treated for moisture resistance.
D. Cleaning Solutions: Non-acidic, not harmful to masonry work or adjacent materials.
E. Isolation material: Asphalt impregnated box board (Locate at Structural Steel).
F. Weep holes/vents: Dor-O-Wall, Cell Vent or equal product.
G. Cavity Drainage Material: Mortar Net or equal product.
H. Non-Shrink Grout: Euclid Chemical Company Dry Pack Grout.
I. Single-Wythe Concrete Masonry Unit Drainage System: BlockFlash
    1. Product: Subject to compliance with requirements, provide “BlockFlash” as manufactured by Mortar Net Solutions.

2.7 LINTELS

A. Precast Concrete Lintels: Second type, 8 inches high x wall width size, 9000 psi strength at 28 days.
B. Length of lintel shall be opening plus 16 inches.
C. Lintels not specifically sized by Drawings and detail sections of this contract shall comply with the following:
    1. Walls or veneers of 4" or less in thickness:
        a. 3-1/2" x 4" x5/16" angle, L.L.V. (ext. walls)
        b. 3-1/2" x 4" x ¼" angle, L.L.V. (int. walls)
    2. Walls 8" or more in thickness (for each 4" width of masonry thickness):
        a. Up to 4'-0" wide opening: (1) 3-1/2" x 5" x 5/16" angle.
        b. Over 4'-0" up to 7'0" wide opening: (1) 3-1/2" x 5" x 5/16" angle.
        c. Over 7'0" up to 12'-0" wide opening: Steel beam with a bottom plate.
        d. Over 12'-0" wide opening: structural lintel required.
    3. Variation to above will require structural lintel review by Architect-Engineer.

2.8 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I, except Type III may be used for cold-weather construction.
B. Hydrated Lime: ASTM C 207, Type S.
C. Aggregate for Mortar: ASTM C 144.
D. Aggregate for Grout: ASTM C 404.
E. Water: Clean and potable.
F. Masonry cement mortar is <u>not</u> acceptable.
G. Color: To be selected from manufacturers full sample range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.
B. Verify items provided by other Sections of work are properly sized and located.
C. Verify that built-in items are in proper location, and ready for roughing into masonry work.
D. Beginning of installation means installer accepts existing conditions.

3.2 PREPARATION

A. Direct and coordinate placement of metal anchors supplied to other Sections.
B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.3 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement. Masonry units displaced must be removed and replaced with new units.
B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
C. Lay concrete masonry units in running bond unless otherwise indicated. Course one unit and one mortar joint to equal 8 inches. Form concave mortar joints, unless indicated otherwise.

3.4 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
B. Lay hollow masonry units with face shell bedding on head and bed joints.
C. Buttering corners of joints or furrowing of mortar joints are not permitted.
D. Remove excess mortar as Work progresses.
E. Interlock intersections and external corners.
F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove masonry units, mortar and replace.
G. Perform jobsite cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
H. Cut mortar joints flush where resilient base is scheduled, or cement plaster is applied.
I. Isolate masonry partitions from vertical structural steel framing members with isolation material.
J. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.5 CAVITY

A. Keep cavity clean of mortar droppings and other materials.
B. Install “Mortar Net”, or equivalent product, in accordance with manufacturer’s instructions.
C. Install CMU cell flashing pans with built in adjoining bridge made from recycled polypropylene with chemical stablizers that prevent UV degradation. Flashing pans have a sloped design to direct moisture to the integrated weep spout. Designed to be built into mortar bed joints to expel moisture (unimpeded by mortar droppings) to the exterior of CMU walls. Drainage Mats and Insect Guards included.

3.6 VENEER ANCHORING

A. 1. Fasten anchors through sheathing to metal studs with two metal fasteners per anchor.
2. Space anchors not more than 16 inches vertically and 16 inches horizontally.

3.7 CONTROL JOINTS

A. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
B. Size control joint in accordance with Section 07 9200 for sealant performance.
C. Provide control joints where length at masonry wall exceeds 20 feet or as otherwise indicated.

3.8 BUILT-IN WORK

A. As work progresses, build in metal door and glazed frames, fabricated metal frames, window frames, anchor bolts, plates, and other items furnished by other Sections.
B. Build in items plumb and level.
C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
D. Do not build in organic materials subject to deterioration.

3.9 TOLERANCES

A. Maximum Variation From Unit to Adjacent Unit: 1/16 inch, unless approved otherwise.
B. Maximum Variation From Plane of Wall: 1/4 inch in 10 feet and 1/2 inch in 20 feet or more.
C. Maximum Variation From Level Coursing: 1/8 inch in 3 feet and 1/4 inch in 10 feet; 1/2 inch in 30 feet. (non-cumulative)
D. Maximum Variation of Joint Thickness: 1/8 inch.
E. Maximum Variation From Cross Sectional Thickness of Walls: 1/8 inch.

3.10 CUTTING AND FITTING

A. Cut and fit for chases, pipes, conduit, and sleeves. Coordinate with other Sections of work to provide correct size, shape, and location.
B. Obtain Architect-Engineer approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.11 CLEANING

A. Coordinate with Architect-Engineer to locate an inconspicuous masonry area on which to apply cleaning solutions and techniques.
B. Verify compatibility of cleaning solutions and techniques on masonry before commencing on remainder of masonry surfaces.
C. Remove excess mortar and mortar smears.
D. Replace defective mortar. Match adjacent work.
E. Clean soiled surfaces with cleaning solution.
F. Use "Bucket and Brush Hand Cleaning" techniques per Brick Institute of America's Technical note 20, revised.

3.10 PROTECTION OF FINISHED WORK

A. Protect finished installation.
B. Without damaging completed work, provide protective boards at exposed external corners which may be damaged by construction activities.

END OF SECTION 04 2000

SECTION 05 1200
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes structural steel.

1.2 DEFINITIONS
A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 SUBMITTALS
A. Shop Drawings: Show fabrication of structural-steel components.

1.4 QUALITY ASSURANCE
A. Fabricator Qualifications: A qualified fabricator that possesses 5 years of experience with structures of similar size and scope, AISC certified or an acceptable QA/AC program, as determined by the Engineer and Building Code requirements.
B. Installer Qualifications: A qualified fabricator that possesses 5 years of experience with structures of similar size and scope, AISC Certified or an acceptable QA/AC program, as determined by the Engineer and Building Code requirements.
C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
D. Comply with applicable provisions of the following specifications and documents:
   1. AISC 303.
   2. AISC 360.
   3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS
A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
B. W-Shapes: ASTM A 992/A 992M.
C. Channels, Angles ,M, S-Shapes: ASTM A 36/A 36M or A 992/A 992M.
D. Plate and Bar: ASTM A 36/A 36M.
E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
G. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS
A. High-Strength Bolts, Nuts, and Washers: Type 1, heavy-hex steel structural bolts, either ASTM A 325 (ASTM A 325M), Type 1, or ASTM A 490 (ASTM A 490M), or tension-control bolt-nut-washer assemblies listed below.
   1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.
B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   1. Finish: Plain.
C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
D. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.

1. Finish: Plain.

E. Threaded Rods: ASTM A 36/A 36M.
   1. Finish: Plain.

2.3 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat, and color shall be light gray.

2.4 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 360.

B. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

2.5 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 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

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 (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 (applied fireproofing).
   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 3, "Power Tool Cleaning."

C. 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 (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: 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. 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."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
   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.

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.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
   1. Set plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of baseplate.
   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 plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and 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 within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 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.
B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

3.4 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: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    a. Liquid Penetrant Inspection: ASTM E 165.
    b. 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.
    c. Ultrasonic Inspection: ASTM E 164.
    d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION 05 1200

SECTION 05 1213
ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General Conditions and Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Architecturally Exposed Structural-Steel Framing, such as tube steel columns in the office and concourse areas.

B. Related Sections:
   1. Division 01 Section “Quality Requirements” for independent testing agency procedures and administrative requirements.
   2. Division 05 Section “Structural Steel Framing”. Requirements in Division 05 Section “Structural Steel Framing” also apply to AESS framing.
   3. Division 05 Section “Metal Fabrications” for metal items not defined as structural steel.
   4. Division 09 Section “Painting”, for surface preparation and priming requirements.

1.3 DEFINITIONS

A. Architecturally Exposed Structural Steel: Structural steel designated as “architecturally exposed structural steel” or “AESS” in the Contract Documents.

B. Category 2 AESS: AESS that is within 20 feet vertically and horizontally of a walking surface and is visible to a person standing on that walking surface or is designated as "Category 2 architecturally exposed structural steel" or "AESS-2" in the Contract Documents.

1.4 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 type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections. Indicate orientation of bolt heads.
   5. Indicate exposed surfaces and edges and surface preparation being used.

6. Indicate special tolerances and erection requirements.

B. Qualification Data: For qualified Installer fabricator and testing agency.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

B. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P3 or SSPC-QP 3, “Standard Procedure for Evaluating Qualifications of Shop Painting Applicators”.

D. Preinstallation Conference: Conduct conference at Project site.

1.6 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.

1.7 PROJECT CONDITIONS

A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions 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' recommendations to ensure that shop primers and topcoats are compatible with one another.

PART 2 - PRODUCTS

2.1 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 to remove burrs and provide smooth surfaces and edges.

3. Fabricate 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 2 and 3 AESS to the tolerances specified in AISC 303 for steel that is not designated AESS.

C. 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. Do not thermally cut bolt holes or enlarge holes by burning.
2. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.2 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.

B. Weld Connections: Comply with AWS D1.1 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 AESS is exposed to weather.
4. Grind butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus 0 inch for Category 2 AESS.
5. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for Category 2 AESS.
6. At locations where welding on the far side of an exposed connection of Category 2 AESS occurs, grind distortions and marking of the steel to a smooth profile aligned with adjacent material.
7. Make fillet welds for Category2 AESS oversize and grind to uniform profile with smooth face and transition.

2.3 GALVANIZING

A. 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.

3.3 ERECTION

A. Set AESS accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
   1. Erect Category 2 AESS to the tolerances specified in AISC 303 for steel that is not 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.

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 and Category 2 AESS.
   2. Remove erection bolts in Category 2 AESS, fill holes, and grind smooth.
   3. Fill weld access holes in Category 2 AESS and grind smooth.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: The Contractor shall 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. 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.

C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

END OF SECTION 05 1213

SECTION 05 2100
STEEL JOISTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Open-web steel joists with bridging, seats and anchor bolts.
   2. Loose bearing plates and anchor bolts.
   3. Framed floor and roof openings greater than 18 inches.

1.3 REFERENCES

A. ASTM A108 – Steel Bars, Carbon, Cold-Finished, Standard Quality.
B. ASTM A153 – Zinc coating (Hot Dip) on Iron and Steel Hardware.
C. ASTM A307 – Carbon Steel Threaded Standard Fasteners.
D. ASTM A325 – High Strength Bolts for Structural Steel Joints.
E. AWS D1.1 – Structural Welding Code.
F. FS TT-P0636 – Primer Coating, Alkyd, Wood and Ferrous Metal.
G. SJI – Specifications for Longspan Steel Joists LH and LJ Series and Deep Longspan Steel Joists DLH and DLJ series.
H. SSPC – Steel Structures Painting Council.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads within limits and under conditions indicated.
B. Design joists to withstand design loads with live load deflections no greater than the following:
   1. Roof Joists: Vertical deflection of 1/360 of the span.

1.5 SUBMITTALS

A. Product Data: For each type of joist, accessory, and product indicated.
B. Shop Drawings: Show layout, mark, number, type, location, and spacing of joists. Include joining and anchorage details, bracing, bridging, accessories; splice and connection locations and details; and attachments to other construction.
   1. Indicate locations and details of anchorage devices and bearing plates to be embedded in other construction.
   2. Comprehensive engineering analysis by the qualified professional engineer responsible for its preparation.
C. Welding Certificates: Copies of certificates for welding procedures and personnel.
D. Mill certificates signed by manufacturers of bolts certifying that their products comply with specified requirements.
E. 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.

F. Research/Evaluation Reports: Evidence of steel joists' compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing joists similar to those indicated for this Project and with a record of successful in-service performance.
   1. Manufacturer must be certified by SJI to manufacture joists complying with SJI standard specifications and load tables.
   2. Assumes responsibility for engineering special joists to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
   3. Professional Engineer Qualifications: A professional engineer who is legally authorized 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 joists that are similar to those indicated for this Project in material, design, and extent.

B. SJI Specifications: Comply with SJI's "Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders" (hereafter, "Specifications"), applicable to types of joists indicated.

C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel"; and AWS D1.3 "Structural Welding Code--Sheet Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.8 SEQUENCING

A. Deliver steel bearing plates and other devices to be built into concrete and masonry construction.

1.9 FIELD MEASUREMENTS

A. Verify that field measurements are as shown on drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE FABRICATORS

A. Vulcraft

B. Canam Steel

C. Socar

D. Ceco
E. Substitutions: Under provisions of Sections 01 6000. All substitutions must be members of S.J.I.

2.2 MATERIALS

A. Steel: Comply with SJI's "Specifications" for chord and web members.
   1. Recycled Content: 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 60 percent.

B. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
C. High-Strength Bolts and Nuts: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
   1. Finish: Plain, uncoated.
D. Welding Electrodes: Comply with AWS standards.

2.3 PRIMERS

A. Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements in FS TT-P-664.

2.4 OPEN-WEB K-SERIES STEEL JOISTS

A. Manufacture steel joists according to "Standard Specifications for Open Web Steel Joists, K-Series," in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord; of joist type indicated.
B. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
C. Provide holes in chord members for connecting and securing other construction to joists.
D. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."
E. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."
F. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.5 LONG SPAN STEEL JOISTS

A. Manufacture steel joists according to “Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series” in SJI’s “Specifications,” with steel angle top and bottom chord members; of joist type, end and top-chord arrangements as indicated.

2.6 JOIST ACCESSORIES

A. Bridging: Fabricate as indicated and according to SJI's "Specifications."
   1. Furnish additional erection bridging if required.

B. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.

2.7 CLEANING AND SHOP PRIMING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories to be primed by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.

B. Apply one shop coat of primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing, 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. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.
   1. Before installation, splice joists delivered to Project site in more than one piece.
   2. Space, adjust, and align joists accurately in location before permanently fastening.
   3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
   4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads have been applied.

C. Field weld joists to supporting steel bearing plates. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using high-strength structural bolts, unless otherwise indicated. Comply with RCSC's "Allowable Stress Design Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" or high-strength structural bolt installation and tightening requirements.

E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

F. Frame floor and roof openings greater than 18 inches with supplementary framing.
G. Do not permit erections of decking until joists are braced, bridged and secured.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
B. Field welds will be visually inspected according to AWS D1.1.
C. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following procedures, as applicable:
   1. Magnetic Particle Inspection: ASTM E 709.
D. Bolted connections will be visually inspected.
   1. High-strength, field-bolted connections will be tested and verified according to procedures in RCSC's "Allowable Stress Design Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."
E. Correct deficiencies in Work that inspections and test reports have indicated are not in compliance with specified requirements.
F. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

3.4 REPAIRS AND PROTECTION

A. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories.
   1. Clean and prepare surfaces by hand-tool cleaning, SSPC-SP 2, or power-tool cleaning, SSPC-SP 3.
   2. Apply a compatible primer of the same type as the shop primer used on adjacent surfaces.
B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure joists and accessories are without damage or deterioration at time of Substantial Completion.

3.5 ERECTION TOLERANCES

A. Maximum Variation from Plumb: ¼ inch.
B. Maximum offset from true alignment: ¼ inch.

END OF SECTION 05 2100

SECTION 05 3100
STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Roof deck.
   2. Non-composite form deck.

1.2 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, cut deck openings, special jointing, accessories, and attachments to other construction.

1.3 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
B. 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."

1.4 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.

PART 2 - PRODUCTS

2.1 ROOF DECK

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
B. 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. 30, and with the following:
   1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating.
   2. Deck Profile: As indicated.
   3. Profile Depth: As indicated.
   4. Design Uncoated-Steel Thickness: As indicated.

2.2 NON-COMPOSITE FORM DECK

A. Noncomposite Steel Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with 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.
   3. Design Uncoated-Steel Thickness: As indicated.
   4. Span Condition: Double span minimum, or as otherwise indicated.

2.3 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 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, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
F. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, requirements in this Section, and as indicated.
B. 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.
C. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
E. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
F. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
G. Mechanical fasteners may be used in lieu of welding to fasten deck, except welds required to create the necessary diaphragm strength, consult with Engineer. Locate mechanical fasteners and install according to deck manufacturer's written instructions.
H. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches.
I. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds or mechanical fasteners not more than 9 inches apart with at least one weld or fastener at each corner.
    1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasteners.
J. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
    1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

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 deck.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: 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. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
D. Remove and replace work that does not comply with specified requirements.
E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.3 REPAIRS

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. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

END OF SECTION 05 3100

SECTION 05 4000
COLD FORMED METAL FRAMING

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this section :

1.2 SUMMARY

A. This Section includes exterior load-bearing fasia framing.

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 follows:
      a. Dead Loads: Weights of materials and construction.
      b. Wind Loads: 90 mph, Exposure C, 60 ft height.
   2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than L/360 or L/600 of the span for exterior or otherwise sensitive to movement.

1.4 SUBMITTALS

A. Product Data: For each type of product and accessory indicated.
B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
   1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by a qualified professional engineer registered in the State of Michigan and responsible for their preparation.
C. Welding certificates.
D. Qualification data.
E. Product test reports.
F. Research/evaluation reports.

1.5 QUALITY ASSURANCE

A. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements.
B. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code--Sheet Steel."
C. 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."

PART 2 - PRODUCTS

2.1 MATERIALS

A. 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.

2.2 EXTERIOR LOAD-BEARING 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: Per structural performance requirements.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and same minimum base-metal thickness as steel studs.

2.3 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003, Structural Grade, metallic coated, of same grade and coating weight used for framing members, unless otherwise indicated.

B. 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.

2.4 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, or ASTM A 780.

B. Shims: Load bearing, high-density multimonomer plastic, nonleaching.

C. 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.

PART 3 - EXECUTION

3.1 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.

C. Install framing members in one-piece lengths.

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 (1:960) 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.

3.2 EXTERIOR LOAD-BEARING 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. Do not fasten studs to deflection track, such as in infill wall framing. Space studs as follows:

1. Stud Spacing: As indicated.

C. Set studs plumb or horizontal, except as needed for diagonal bracing.

D. 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 curtain-wall-framing system.

3.3 FIELD QUALITY CONTROL

A. Field and shop welds will be subject to testing and inspecting.

B. Testing agency will report test results promptly and in writing to Contractor and Architect.

C. Remove and replace work where test results indicate that it does not 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.

3.4 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 05 4000

SECTION 05 5000
METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Steel framing and supports for applications where framing and supports are not specified in other Sections.
B. Roof ladder.
C. Steel angle supports at roof openings.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Paint products.
B. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
C. Welding Certificates: Copies of certificates for welding procedures and personnel.
D. 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.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing metal fabrications 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.
B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code."
   2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 PROJECT CONDITIONS

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and

fitting.

1.6 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. 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: For metal fabrications 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, rolled trade names, or roughness.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.
B. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633, 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 325, and A36 (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
C. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
D. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
E. Plain Washers: Round, carbon steel, ASME B18.22.1 (ASME B18.22M).
F. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1
G. (ASME B18.21.2M).
H. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as needed.

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. 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. Shear and punch metals cleanly and accurately. Remove burrs.
C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
D. 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.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

H. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

I. Remove sharp or rough areas on exposed traffic surfaces.

J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports indicated and as necessary to complete the Work.

B. Fabricate units from structural-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 retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

C. Galvanize miscellaneous framing and supports where indicated or where built into exterior walls.

2.6 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123, for galvanizing steel and iron products.

B. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, “Paint Application Specification No. 1”, for show painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.

B. 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.

C. Provide temporary bracing or anchors in formwork for items that are to be

built into concrete, masonry, or similar construction.

D. 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.

E. Field Welding: Comply with the following requirements:
   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.

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.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 Section "Painting."

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 5000

SECTION 05 5100
METAL STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Preassembled steel stairs with steel plate treads.
B. Steel tube railings attached to metal stairs or walls adjacent to 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 SUBMITTALS

A. Product Data: For metal stairs.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
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 QUALITY ASSURANCE

A. 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.

PART 2 - PRODUCTS

2.1 METALS

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.
B. Steel Plates, Shapes, and Bars: ASTM A 36.
C. Steel Tubing: ASTM A 500.
D. Rolled-Steel Floor Plate: ASTM A 786, rolled from plate complying with ASTM A 36 or ASTM A 283, Grade C or D.
E. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011, either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.

2.2 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

2.3 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.
C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
D. Form bent-metal corners to smallest radius possible without impairing work.
E. 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 unless otherwise indicated.
   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.
F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.

G. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.4 STEEL-FRAMED STAIRS

A. Acceptable Manufacturers: As an option to the above, subject to compliance with requirements, provide comparable products by one of the following, as accepted by the Architect:
   1. Alfab, Inc.
   2. American Stair, Inc.
   3. Sharon Companies Ltd. (The).

B. Stair Framing:
   1. Fabricate stringers of steel channels.
   2. Construct platforms of steel channel headers and miscellaneous framing members as needed to comply with performance requirements.
   3. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
   4. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. General: Form risers, treads, and platforms to configurations shown from steel checker plate of thickness needed to comply with performance requirements.

2.5 STAIR RAILINGS

A. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.
   1. Rails and Posts: 1 ½ inch O.D. top and bottom rails and 1-1/2-inch posts.
   2. Picket Infill: 1/2-inch O.D. pickets spaced less than 4 inches clear.

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 by bending.

D. Form curves by bending members in jigs to produce uniform curvature without buckling.

E. Close exposed ends of railing members with welded end fittings.

F. Provide wall returns at ends of handrails.

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.
   1. Connect posts to stair framing by direct welding.

H. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, to transfer wall bracket loads through wall finishes. Size fillers to suit wall finish thicknesses.

2.6 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. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning".
D. Apply shop primer to uncoated surfaces of metal stair components. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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.
B. Install metal stairs by attaching to hollow core precast concrete floor planks and masonry walls.
C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints.
D. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
E. Attach handrails to stringers or wall as applicable, by welding to stringers or bolting to wall.

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.

END OF SECTION 05 5100

SECTION 055213
METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Stainless steel handrails and guard railings.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. 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.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.3 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 each type of exposed finish required.

D. 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.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Stainless Steel Pipe and Tube Railings:
      a. Local fabricators acceptable to the Architect.

2.2 METALS, GENERAL

A. 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. Tubing: Type 304 Stainless Steel.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for stainless steel welded.

2.5 FABRICATION

A. 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.
B. Form work true to line and level with accurate angles and surfaces.
C. 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. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
D. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
E. Form changes in direction by bending.
F. Bend members in jigs to produce uniform curvature without buckling or otherwise deforming exposed surfaces.
G. Close exposed ends of railing members with end fittings.
H. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

2.6 STEEL FINISH

A. #4 Satin.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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 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.

B. Provide non-shrink grout to anchor posts at concrete stairs.

C. Attach railings to wall with wall brackets. Use type of bracket with predrilled hole for exposed bolt anchorage.

D. Secure wall brackets and railing end flanges to building construction as follows:
   1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   2. For hollow masonry anchorage, use toggle bolts.

3.2 ADJUSTING AND CLEANING

A. Touchup: Immediately after erection, clean field welds, bolted connections, and scratched or abraded areas to match level of shop finishing.

END OF SECTION 05 5200

SECTION 05 7300
DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pre-engineered square post stainless steel railing system. All drawings, general and supplementary conditions including division one specifications apply to this section.

1.2 PRODUCT REFERENCES AND DESIGN REQUIREMENTS

A Principle items specified in this section are:
1. Stainless steel and Stainless handrails.
2 Stainless steel horizontal or picket infill rods.

B. Design requirements are based on IBC/IRC and ADA standards:
1. Guardrails and handrails shall meet or exceed all applicable building codes.
2. Railings shall have high strength stainless steel to comply with structural requirements with an appropriate safety margin.
3 All internal members shall be stainless steel, aluminum or nylon to eliminate the possibility of rust.
4 Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

C Work Included:
1. Provide all materials, labor and equipment necessary to fabricate and completely install handrails, guardrails, infill panels, and other railing options as shows on drawings or specific herin.

D. Definitions
1. Terms and definitions from ASTM E985 and ISO/TC 59 for railing related items apply to this section.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A Railings shall meet or exceed the requirements of all applicable building codes.

B Railings shall have high strength stainless steel in order to comply with 1.41 with adequate safety margin.

C. All internal members shall be stainless steel, nylon or wood to eliminate the possibility of rust.

D Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

A. Shop Drawings for architectural approval, showing fabrication and installation of handrails and railings including plans, elevations, sections, details of components and attachments to other units of work.

B. Product data for stainless steel/wood products to be supplied by the manufacturer.

C. Structural computations or test data/evaluations, material properties, PE (professional engineering) calculations signed/sealed in the State of the project, and other information needed to ensure satisfactory structural compliance to applicable building codes to be supplied by the manufacturer, based on final fabrication drawings and documents.

D, Maintenance instructions: Provide manufacturer‘s maintenance and cleaning instructions.

E. Warranty: Provide manufacturer‘s warranty effective from completion of work.

F. Initial selection:

1. Provide 6“ long handrail samples complete with supports and rosette covers to demonstrate stainless steel grade and finish. Nylon components to be includes if specified, color as indicated.

G. Final verification:

1. Qualification data for authorized installers specified in Quality Assurance is to demonstrate their capabilities and experience. Include list of completed projects with project and architect names.

1.5 QUALITY ASSURANCE

A. Single Source Responsibility: Materials shall be supplied by a single meanufacturer

B. Execution tolerance plus/minus 5/64” (2 mm).

1.6 STORAGE

A. Store handrails and railing systems in clean, dry location, away from uncured concrete and masonry, protected against damage of any kind.

B. Materials must be kept in original packing until installation.

C. Materials to be stored at not lower than -40°C (-104°F) or higher than 100°C (212°F).

1.7 PROJECT CONDITIONS

A. All measurements for handrails and railings should be taken from construction site elements to which railings are to fasten. This information to be recorded on final shop drawings.

B. Coordinate fabrication schedule with construction progress to avoid delay of work

PART 2 - <u>PRODUCT</u>

2.1 MANUFACTURER

A. Mechanically fastened Stainless steel railing systems.

1. Design Standard: Circum™ Square Post Railing System HDI Railing Systems, 3905 Continental Drive, Columbia PA, 17512 (Tel. 717.285.4088 Fax. 717.285.5083).
2. J.G. Braun Co.
3. Zephyr Architectural Metals.
4. Julius Blum Co.
5. Approved Equal.

2.2 MATERIALS FOR GUARDRAILS AND HANDRAIL SYSTEM

A. All hand rails and other tubular components shall be constructed using the following.

B. Stainless steel grade type AISI 304/304L or 316/316L; surface to be 240 grain/grit finish; tubes 1-1/2" (38mm) outside diameter by 5/64" (2 mm) wall thickness.

C. All posts and other components shall be constructed using the following:

1. Stainless steel grade AISI type 304 or 316, surface to be 240 grain/grit finish; tubes 2" by 2" (51mm) diameter by 0.125" (3.2mm) wall thickness.
2. Stainless steel grade AISI type 304 or 316, surface to be 240 grain/grit finish for: end caps at top of posts. Hardware for handrail attachment to match finish of posts.
3. Stainless steel grade AISI type 304 or 316, surface to be 240 grain/grit (#6) finish for post fastening base plate

D. Fastening bolts to be stainless steel or other high strength material as determined by engineering requirements.

E. Exterior and aggressive environments require stainless steel grade AISI 316 or 316L to minimize maintenance requirement; surface to be 240 grain/grit (#6) finish.

2.5 STAINLESS STEEL INFILL RAILS

A. Stainless steel infill rods, max. 9 ea.with guardrail height 42". Infill rails to be 3/8" (9.5 mm) diameter solid stainless steel. Brushed finish #6 polished radially. Clamping knobs and fixtures to be stainless steel finished to match. Horizontal infill rails on approx. 4" (100 mm) centers, gaps between rods and adjacent posts to be equalized depending on required rail length and site conditions not to exceed 4" (100 mm).

2.10 FASTENERS

A. Anchors shall be fabricated from stainless steel or other materials as determined by engineering requirements with capability to sustain, without failure, load imposed within a safety factor of 4, as determined by testing per ASTM E488.

2.11 FABRICATION

A. Fabricate railing system for compliance with structural requirements of applicable code.

B. Pre-assemble railings prior to shipping to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for re-assembly and for coordination with shop drawings.

C. Stainless steel tubing cuts shall be square, without burrs and where exposed, rounded to produce smooth rigid and hairline joints.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify that reinforcement and anchoring devices are the correct type, have been located correctly, and have been installed properly.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Provide information on fastening point locations for posts where necessary to relevant parties.

3.3 INSTALLATION

A. Installation shall be by a qualified, authorized representative of the manufacturer.

1. Installation must be in accordance with standard or non-standard, yet applicable details (instructions) included on installation/shop drawings.
2. Install components plumb and in-line, accurately fitted, free from distortion or defects and securely anchored to structure.
3. Provide anchors, plates, angles, etc., necessary for connecting railings to structure.
4. Any and all field welding shall be by a certified welder.
5. Access for anchors that require through bolting either vertically or horizontally to be made available through General Contractor.

3.4 ERECTION TOLERANCES

A. Maximum variation from plumb shall be 1/4" (6mm).

B. Maximum offset from true alignment for every 50-foot of railing shall be 1/4" (6 mm), non-accumulative.

3.5 CLEANING AND PROTECTION

A. Remove manufacturer's protective coverings from exposed surfaces after installation.

B. Railings shall be cleaned, including infill panels, by contractor to the satisfaction of the owner.

C. Wipe with moistened cloth only. Do not use cleaning agents with abrasive or acid/alkaline content.

D. General contractor to provide protective covering on handrails and guardrails if construction is not yet finished in the area where the railings are installed.

E. Railings shall be cleaned, including infill panels, by contractor to the satisfaction of the owner.

F. Wipe with moistened cloth only. Do not use cleaning agents with abrasive or acid/alkaline content.

3.6 CORRECTION OF DEFICIENCIES

A. All deficiencies in work and/or items not meeting specified requirements shall be corrected in order to meet specification requirements at no additional cost to owner.

END OF SECTION 05 7300

SECTION 06 1000
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Wood nailers and blocking.
   2. Wood treatment.
   3. Utility mounting boards.

1.3 PERFORMANCE REQUIREMENTS

A. Design Requirements for Roof Nailers at Low Slope Roofs: Comply with 2009 Michigan Building Code for roof edge wind loads.
   1. Wood: At least 1.5" thick. Pressure treated wood. Holes with countersinks for fasteners.
      a. Where the nailer secures the roofing, such as gravelstops, the nailer shall extend at least 1/2 inch beyond the back edge of the flange.
   2. Fasteners: Corrosion resistant anchor bolts attached with nuts and washers.
      a. Locate a fastener 3 to 4 inches from each end of each nailer member.
      b. At nailers wider than 6-inch, stagger the fasteners to avoid splitting the wood.
      c. Space fasteners no more than 12" o.c., and penetrate deep enough to achieve design pullout resistance.
      d. In corner regions (dimension of 10 percent of the lesser of the building height or length), space fasteners at 6" o.c.
      e. Anchor bolt size and spacing shall resist a vertical wind load of at least 200 lb per ft, with a safety factor of 4.5 for wood, 3.0 for masonry, or 1.9 for steel, reduced by 25 percent.
      f. Provide at least 2 fasteners per nailer member.
   3. Air Seal: If the roof edge serves as an air seal, seal the nailers with proper sealant. Seal between multiple layers and seal butt joints.

1.4 DEFINITIONS

A. Rough Carpentry: Carpentry work not specified in other Sections and not exposed, unless otherwise specified.

1.5 SUBMITTALS

A. Product Data for the following products:
   1. Metal framing anchors.
   2. Construction adhesives.

B. Wood treatment data as follows, including chemical treatment manufacturer's instructions for handling, storing, installing, and finishing treated materials:

C. Warranty of chemical treatment manufacturer for each type of treatment.
D. Research or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence the following products' compliance with building code in effect for Project.
1. Metal framing anchors.
2. Power-driven fasteners.

1.6 QUALITY ASSURANCE

A. Single-Source Responsibility for Preservative-Treated Wood: Obtain each type of treated wood product from one source and by a single producer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.
1. For lumber and plywood treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Wood-Treated Materials:
a. Baxter: J. H. Baxter Co.
b. Chemical Specialties, Inc.
c. Continental Wood Preservers, Inc.
d. Hickson Corp.
e. Hoover Treated Wood Products, Inc.
f. Osmose Wood Preserving, Inc.
2. Metal Framing Anchors:
a. Cleveland Steel Specialty Co.
b. Harlen Metal Products, Inc.
c. Silver Metal Products, Inc.
d. Simpson Strong-Tie Company, Inc.
e. Southeastern Metals Manufacturing Co., Inc.

2.2 LUMBER, GENERAL

A. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.
B. Inspection Agencies: Inspection agencies, and the abbreviations used to reference them, include the following:
1. NELMA - Northeastern Lumber Manufacturers Association.
2. NLGA - National Lumber Grades Authority (Canadian).
3. RIS - Redwood Inspection Service.
4. SPIB - Southern Pine Inspection Bureau.
5. WCLIB - West Coast Lumber Inspection Bureau.
6. WWPA - Western Wood Products Association.

C. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
   1. For exposed lumber, furnish pieces with grade stamps applied to ends or back of each piece, or omit grade stamps and provide grade-compliance certificates issued by inspection agency.

D. 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.
   1. Provide dressed lumber, S4S, unless otherwise indicated.
   2. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch normal (38 mm actual) thickness or less, unless otherwise indicated.

2.3 WOOD-PRESERVATIVE-TREATED MATERIALS

A. General: Where lumber or plywood is indicated or is specified to be treated, comply with applicable requirements of AWPA C2 (lumber) and AWPA C9 (plywood). Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.
   1. Do not use chemicals containing chromium or arsenic.
   2. For exposed items indicated to receive painted finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

B. Pressure treat aboveground items with waterborne preservatives to a minimum retention of 0.25 lb/cu. ft. After treatment, kiln-dry lumber and plywood to a maximum moisture content of 19 and 15 percent, respectively. Treat indicated items and the following:
   1. Wood nailers, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

C. Complete fabrication of treated items before treatment, where possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

2.4 FIRE-RETARDANT TREATMENT BY PRESSURE PROCESS

A. General: When fire-retardant-treated wood is indicated, pressure impregnate lumber and plywood with fire-retardant chemical to comply with AWPA C20 and C27, respectively, for treatment type indicated; identify “fire-retardant-treated wood” with appropriate classification marking of Underwriters Laboratories, Inc., U.S. Testing, Timber Products Inspection, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Current evaluation/Research Reports: Provide fire-retardant-treated wood for which a current model code evaluation/research report exists that is acceptable to authorities having jurisdiction and that evidences compliance of fire-retardant-treated wood for application indicated.

B. Interior Type A: For interior locations use fire-retardant chemical formulation that produces treated lumber and plywood with the following properties under conditions present after installation.

1. No reduction takes place in bending strength, stiffness, and fastener holding capacities below values published by manufacturer of chemical formulation that are based on tests by a qualified independent testing laboratory of treated wood products identical to those indicated for this Project under elevated temperature and humidity conditions simulating installed conditions.
2. No other form of degradation occurs due to acid hydrolysis or other causes related to manufacturer and treatment.
3. No corrosion of metal fasteners results from their contract with treated wood.

C. Inspect each piece of treated wood or plywood after drying and discard damaged or defective pieces.

2.5 DIMENSION LUMBER

A. General: Provide dimension lumber of grades indicated according to the ALSC National Grading Rule (NGR) provisions of the inspection agency indicated.

B. Miscellaneous Framing: Provide the following grades and species:
1. Grade: No. 2.
2. Species: Southern pine; SPIB.

2.6 BOARDS

A. Concealed Boards: Where boards will be concealed by other work, provide lumber with 19 percent maximum moisture content and of following species and grade:
1. Species and Grade: Mixed southern pine, No. 2 per SPIB rules.

2.7 PLYWOOD MATERIALS

A. Utility Mounting Boards: APA Structural I, Grade AB, ¾" minimum thickness; exterior glued, fire retardant treated.

2.8 MISCELLANEOUS LUMBER

A. General: Provide lumber for support or attachment of other construction, including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping, and similar members.

B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.

C. Moisture Content: 19 percent maximum for lumber items not specified to receive wood preservative treatment.

2.9 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
1. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of Type 304 stainless steel.

B. Nails, Wire, Brads, and Staples: FS FF-N-105.

C. Power-Driven Fasteners: CABO NER-272.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1. (ASME B18.2.3.8M)

F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

2.10 MISCELLANEOUS MATERIALS

A. Air Infiltration Barrier: Polyethylene sheet, 0.0061 inch thick, formed by spinning continuous strands of fine high density polyethylene interconnected fibers and bonding them together by heat and pressure; with a moisture vapor transmission rate of 400 grams/sq. meter/24 hours per ASTM E 96, procedure; and a flame spread and smoke developed rating of 5 and 10 respectively per ASTM E 84.

B. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbonate (IPBC) as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.

C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.

D. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.

E. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. Published requirements of metal framing anchor manufacturer.
   2. "Recommended Nailing Schedule" of referenced framing standard and with AFPA's "National Design Specifications for Wood Construction."
   3. “Fastening Schedule” Michigan Building Code.

F. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; pre-drill as required.

G. Use hot-dip galvanized or stainless-steel nails where rough carpentry is exposed to weather, or in area of high relative humidity.

H. Countersink nail heads on exposed carpentry work and fill holes with wood filler.

3.2 AIR INFILTRATION BARRIER

A. Apply Air Infiltration Barrier with 4 inch overlap and 6 inch endlap, continuous over sheathing behind masonry or cast stone veneer.

3.3 WOOD NAILERS AND BLOCKING

A. Install wood nailers and blocking where shown and where required for screeding or attaching other work. Form to shapes shown and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during

installation of masonry work. Where possible, anchor to formwork before concrete placement.

C. Install permanent grounds of dressed, preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

END OF SECTION 06 1000

SECTION 06 4023
INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Finish carpentry items.
   2. Millwork cabinetry.
   3. Hardware and attachment accessories.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 6 Section "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view.
   2. Division 9 Section "Painting" for priming and back priming of finish carpentry.

1.3 SUBMITTALS

A. Product Data for each type of product and process specified, including details of construction relative to materials, dimensions of individual components, profiles, textures, and colors.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed finish carpentry similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.

B. Do not deliver interior finish carpentry until environmental conditions meet requirements specified for installation areas. If finish carpentry must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install interior finish carpentry until building is enclosed and weatherproof, wet-work in space is completed and nominally dry, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels through the remainder of construction period.

B. Weather Limitations: Proceed with installing exterior finish carpentry only when existing and forecasted weather conditions will permit work to be performed according to manufacturer's recommendations and warranty requirements and at least one coat of specified finish to be applied without exposure to rain, snow, or dampness.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," for lumber and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee Board of Review.

B. Inspection Agencies: Inspection agencies, and the abbreviations used to reference them, include the following:
   1. NELMA - Northeastern Lumber Manufacturers Association.
   2. NHLA - National Hardwood Lumber Association.
   3. NLGA - National Lumber Grades Authority.
   4. RIS - Redwood Inspection Service.
   5. SCMA - Southern Cypress Manufacturers Association.
   6. SPIB - Southern Pine Inspection Bureau.
   7. WCLIB - West Coast Lumber Inspection Bureau.
   8. WWPA - Western Wood Products Association.

C. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
   1. For exposed lumber, furnish pieces with grade stamps applied to ends or back of each piece, or omit grade stamps entirely and provide certificates of grade compliance issued by inspection agency.

2.2 SHEET MATERIALS

A. Wood Particleboard: For use where plastic laminate or similar material is fully adhered. Composed of wood chips made with waterproof resin binders of medium 45 pound density; sanded faces; below government standards for formaldehyde content.

2.3 PLASTIC LAMINATE MATERIALS

A. Plastic Laminate: 0.038 inch.
   General Purpose; Color, pattern, and surface finish per drawings. Use where exposed to view.

B. Plastic Laminate Backing: High pressure paper base laminate without a decorative finish; 0.020 inch thick; smooth finish (Melamine). Use at interior of cabinets or where otherwise concealed to view.

2.4 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

2.5 FABRICATION, GENERAL

A. Wood Moisture Content: Comply with requirements of specified inspection agencies and manufacturer's recommendations for moisture content of finish carpentry on relative humidity conditions existing during time of fabrication and in installation areas.
B. Fabricate to AWI Premium standards.
C. Shop Prepare and identify components for grain matching during site erection.

2.6 ADHESIVE

A. Contact Adhesives: FS MMM-A-130; solvent release type.
B. Wall Adhesive: Solvent release, cartridge type, compatible with wall substrate, capable of achieving durable bond.

2.7 SHOP FINISHING

A. Shop finish work to greatest extent possible in accordance with AWI 'Factory Finishing' Section 1500.

2.8 HARDWARE

A. Shelf Standards and Rests: No. 255 standards and No. 256 supports as manufactured by Knape and Vogt.
B. Drawer and door pulls: Anodized aluminum 4" wire pulls, No MC402-4-A by EPCO, or equivalent.
C. Drawer Slides: Side mounted 100lb rated, stainless steel ball bearing full-extension type as manufactured by Knape and Vogt, or equivalent.
D. Hinges: Fully concealed type as manufactured by Julius Blum, or equivalent.
E. Door and drawer locks: Provide master keying for all locks. National Lock Cabinet Hardware C 8100 Series, US 26D finish. Locations as indicated on drawings.
F. Coat Rod: Knape and Vogt 770 series with #764 end flanges.

2.9 SOLID SURFACE FABRICATIONS:

A. Design Standard is indicated on the drawings, subject to compliance with requirements.
B. Fabricate to dimensions, profiles and details indicated.
C. Fabricate openings where indicated or required for work of other trades.
D. Provide side and back splashes where abutting walls, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and performance of finish carpentry. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Condition finish carpentry to average prevailing humidity conditions in installation areas before installation, for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, GENERAL

A. Do not use finish carpentry materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.

1. Do not use manufactured units with defective surfaces, sizes, or patterns.

B. Install finish carpentry plumb, level, true, and aligned with adjacent materials. Use concealed shims where required for alignment.

1. Scribe and cut finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
2. Countersink nails, fill surface flush, and sand where face nailing is unavoidable.
3. Install to tolerance of 1/8 inch in 96 inches for plumb and level. Install adjoining finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.

C. Apply plastic laminate finishes where indicated. Adhere with adhesive over entire surface. Make joints and corners hairline. Match patterns. Slightly bevel arises. Cap exposed edges with plastic laminate of same finish and pattern. Apply laminate backing sheet on reverse side of plastic laminate finished surfaces.

D. Anchor finish carpentry to anchors or blocking built-in or directly attached to substrates. Secure to grounds, stripping and blocking with blind nailing as required for a complete installation. Use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork, and matching final finish.

3.4 ADJUSTING

A. Repair damaged or defective finish carpentry where possible to eliminate functional or visual defects. Where not possible to repair, replace finish carpentry. Adjust joinery for uniform appearance.

3.5 CLEANING

A. Clean finish carpentry on exposed and semi exposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure finish carpentry is without damage or deterioration at the time of Final Completion.

END OF SECTION 06 4023

SECTION 07 1800
TRAFFIC COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
   1. High-performance resinous traffic coating systems.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Installer Certificates for Qualification: Signed by manufacturer stating that installers comply with specified requirements.
C. Material Certificates: For each resinous flooring component, from manufacturer.
D. Maintenance Data: For maintenance manuals.
E. Samples: Submit two 6” X 6” samples of each resinous flooring system applied to a rigid backing. Provide sample which is a true representation of proposed field applied finish. Provide sample color and texture for approval from Owner in writing or approved by General Contractor prior to installation.

1.3 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 approved in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
   2. Installer Letter of Qualification: Installer to provide letter stating that they have been in business for at least 5 years and listing 5 projects in the last 2 years of similar scope. For each project provide: project name, location, date of installation, contact information, size of project, and manufacturer of materials with system information.
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. Pre-installation Conference: Conduct conference at Project site before work and mockups begin.
D. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Do not cover up mockup area.
   1. Apply full-thickness mockups on 16 square foot floor area selected by Architect.
   2. Finish surfaces for verification of products, color, texture, and sheen.
   3. Simulate finished lighting conditions for Architect's review of mockups.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
   5. Mockup shall demonstrate desired slip resistance for review and approval by Owner’s representative in writing.

1.4 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. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.5 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. 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, provide products by:
   1. The Sherwin Williams Company, Cleveland, OH. swflooring@sherwin.com.
   2. Basis of Design Product: Resuflor Topfloor MER II
   3. Substitutions must be approved in writing 10 days prior to bid date.
      a. 1st Coat: Primer Resuprime 3579 applied at 250 sq. ft./gal
      b. 2nd Coat: First base coat Resuflor 3555 applied at 60 sq. ft. / gal.
      c. 3rd Coat: Wearcourse Resuflor 3555 applied at 60 sq. ft. / gal. and broadcast with Broadcast 5310-8 Dry Silica Sand (20-40 mesh) or Other Hard Aggregate at 0.4 lbs/sq ft
      d. 4th Coat: Grout Coat Resuflor 3746 applied at 80 sq. ft./gal
      e. 5th Coat: Topcoat Resuflor 3746 applied at 100-150 sq. ft./gal
      f. Other seal coats available.
      g. Total system thickness: 110-120 mils

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 HIGH-PERFORMANCE RESINOUS FLOORING

A. Resinous Flooring: Abrasion-, impact- and chemical-resistant, high-performance, resin-based, monolithic floor surfacing designed to produce a seamless floor.
B. System Characteristics:
   1. Color and Pattern: As indicated from manufacturers listed above.
   2. Slip Resistance: Provide slip resistant finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspection: Prior to commencing Work, thoroughly examine all underlying and adjoining work, surfaces and conditions upon which Work is in any way dependent for perfect results. Report all conditions which affect Work. No "waiver of responsibility" for incomplete, inadequate or defective underlaying and adjoining work, surfaces and conditions will be considered, unless notice of such unsatisfactory conditions has been filed and agreed to in writing before Work begins. Commencement of Work constitutes acceptance of surfaces.

B. Surface Preparation: Remove all surface contamination, loose or weakly adherent particles, laitance, grease, oil, curing compounds, paint, dust and debris by blast track method or approved mechanical means (acid etch not allowed). If surface is questionable try a test patch. Create a minimum surface profile for the system specified in accordance with the methods described in ICRI No. 03732 to achieve profile CSP 3-5 as follows:

1. Thin film, to 10 mils CSP-1 to CSP-3
2. Thin and medium films, 10 to 40 mils CSP-3 to CSP-5
3. Self-leveling mortars, to 3/16” CSP-4 to CSP-6
4. Mortars and laminates, to 1/4” or more CSP-5 to CSP-10

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. Calcium Chloride Test: Perform anhydrous calcium chloride test per 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. Perform tests so that each test area does not exceed 1000 sq. ft. and perform 3 tests for the first 1000 sq. ft. and one additional test for every additional 1000 sq ft.
   b. In-Situ Probe Test: Perform relative-humidity test using in-situ probes per ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative-humidity-level measurement.

3.2 ENVIRONMENTAL CONDITIONS

A. All applicators and all other personnel in the area of the RF installation shall take all required and necessary safety precautions. All manufacturers’ installation instructions shall be implicitly instructions shall be implicitly followed.

B. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.

C. 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.

D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

E. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

F. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

3.3 APPLICATIONS

A. Install resinous floor over properly prepared concrete surface in strict accordance with the manufacturer's directions.
   1. Install the primer and/or base coats over thoroughly cleaned and prepared concrete.
   2. Install topcoat over flooring after excess aggregate has been removed.
   3. Maintain a slab temperature of 60°F to 80°F for 24 hours minimum before applying floor topping, or as instructed by manufacturer.

B. 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.

C. Sealant: Saw cut resinous floor topping at expansion joints in concrete slab. Fill sawcuts with sealant prior to final seal coat application. Follow manufacturer’s written recommendations.

D. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

E. Slip Resistant Finish: Provide grit for slip resistance.

F. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.4 COMPLETED WORK

A. Cleaning: Upon completion of the Work, clean up and remove from the premises surplus materials, tools, appliances, empty cans, cartons and rubbish resulting from the Work. Clean off all spattering and drippings, and all resulting stains.

B. Protection: Protect Work in accordance with manufacturer's directions from damage and wear during the remainder of the construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

C. Contractor shall insure that coating is protected from any traffic until it is fully cured to the satisfaction of the coating manufacturer.

END OF SECTION 07 1800

SECTION 07 2000
THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Concealed building insulation.
   2. Safing insulation.
   3. Polyurethane Closed Cell Spray Foam Insulation.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 4 Section, “Unit Masonry” for concrete masonry unit core fill insulation.
   2. Division 7 Section, “Penetration Firestopping”.
   3. Division 9 Section “Gypsum Board” for sound attenuation blankets.

1.3 SUBMITTALS

A. Product Data for each type of insulation product specified.

1.4 QUALITY ASSURANCE

A. Single-Source Responsibility for Insulation Products: Obtain each type of building insulation from a single source with resources to provide products complying with requirements indicated without delaying the Work.

B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated on Drawings or specified elsewhere in this Section as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   1. Surface-Burning Characteristics: ASTM E 84.
   2. Fire-Resistance Ratings: ASTM E 119.
   3. Combustion Characteristics: ASTM E 136.

C. Plenum Rating: Provide glass fiber insulation where indicated in ceiling plenums whose test performance is rated as follows for use in plenums as determined by testing identical products per “Erosion Test” and “Mold Growth and Humidity Test” described in UL 181, or on comparable tests from another standard acceptable to authorities having jurisdiction.
   1. Erosion Test Results: Insulation shows no visible evidence of cracking, flaking, peeling, or delamination of interior-surface of duct assembly, after testing for 4 hours at 2500-fpm air velocity.
   2. Mold Growth and Humidity Test Results: Insulation shows no evidence of mold growth, delamination, or other deterioration due to the effects of high humidity, after inoculation with Chaetomium

globosum on all surfaces and storing for 60 days at 100 percent relative humidity in the dark.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide insulation products by one of the following:
   1. Glass-Fiber Insulation: (foil-faced)
      a. CertainTeed Corporation.
      b. Knauf Fiber Glass GmbH.
      c. Owens-Corning Fiberglas Corporation.
      d. Johns-Manville
      e. Schuller International, Inc.

2.2 INSULATING MATERIALS

A. General: Provide insulating materials that comply with requirements and with referenced standards.
   1. Preformed Units: Sizes to fit applications indicated; selected from manufacturer's standard thicknesses, widths, and lengths.

B. Foil-Faced Glass-Fiber Blanket Insulation: Thermal insulation combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665, Type I (blankets with foil facing) for ceiling plenum use.
   1. Mineral-Fiber Type: Fibers manufactured from glass.
   2. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indices of 25 and 450, respectively.

2.3 SAFING INSULATION AND ACCESSORIES

A. Slag-Wool-Fiber Board Safing Insulation: Semirigid boards designed for use as fire stop at openings, produced by combining slag-wool fibers with thermosetting resin binders to comply with ASTM C 612, Type IA and IB; nominal density of 4 lb/cu. ft.; passing ASTM E 136 for combustion characteristics; thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F.

B. Caulking Compound: Material approved by manufacturer of safing insulation for sealing joint between foil backing of safing insulation and edge of concrete floor slab against penetration of smoke.

C. Safing Clips: Galvanized steel safing clips approved by manufacturer of safing insulation for holding safing insulation in place.

2.4 SPRAY FOAM INSULATION

A. Insulation: HFC-blown type Closed Cell Foam: Medium-density, MDI-based polyurethane thermoset rigid foam. When CertaSpray A-side closed cell is mixed with CertaSpray B-side closed cell under pressure in a 1:1 volumetric ratio, they react and expand into a medium-density closed cell foam with an in-place core density of 1.9- 2.2 pcf:

B Physical and Mechanical Properties:
1. Core Density: 1.9-2.4 pcf when tested in accordance with ASTM D1622.

C Thermal Resistance (aged): 5.8 less than or equal to 2-1/2 inches / 6.4 when greater than 2-1/2 inches when tested in accordance with ASTM C 518 at 75 degrees F, (h-ft2- degrees F)/Btu.

D. Thermal Resistance (initial): 6.4 when tested in accordance with ASTM C 518 at 75 degrees F, (h-ft2- degrees F)/Btu.

E. Closed Cell Content: 88-95 percent when tested in accordance with ASTM D 2842.

F. Compressive Strength: Greater than 25 psi when tested in accordance with ASTM D 1621.

G. Tensile Strength: 23 psi when tested in accordance with ASTM D 1623.

H. Water Absorption: Less than 2 percent by volume when tested in accordance with ASTM D 2842.

I. Dimensional Stability: Less than 9 percent by volume when tested in accordance with ASTM D 2126 at 75 degrees F/95 percent RH, 28 Day.

J. Water Vapor Transmission: 1.3 perm/inch when tested in accordance with ASTM E 96.

K. Air Permeability: 0.013 when tested in accordance with ASTM E 283 at 1 inch thickness, L/s/m2.

L. Fungi Resistance: Pass, with no growth when tested in accordance with ASTM C 1338.

M. Fire performance:
1. Flame Spread: Less than 25 when tested in accordance with ASTM E 84.

N. Smoke: Less than 450 when tested in accordance with ASTM E 84.

2.4 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulations, including removing projections capable of puncturing foil facings or that interfere with insulation attachment.

3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, unsoiled, and has not been exposed at any time to ice and snow.

C. Extend insulation in thickness indicated 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. Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

3.4 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between closed-cell (nonbreathing) insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Set foil-faced units with facing to warm side of construction, unless other wise indicated. Do not obstruct ventilation spaces, except for firestopping.

1. Tape joints and ruptures and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Stuff glass-fiber loose-fill insulation into miscellaneous voids and cavity spaces at building perimeter. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.

3.5 INSTALLATION OF SAFING INSULATION

A. Install safing insulation to fill gap at fire rated walls on safing clips spaced as needed to support insulation, but not further apart than 24 inches o.c. Cut safing insulation wider than gap to be filled to ensure compression fit and seal joint between insulation and edge of slab with caulking approved by safing insulation manufacturer for this purpose. Leave no voids in completed installation.

3.6 INSTALLATION OF SPRAY FOAM INSULATION

A. Install in accordance with manufacturer's instructions. Product must be installed according to local code, and must be applied by a qualified applicator.

3.7 PROTECTION

A. General: Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 2000

SECTION 07 2400
EXTERIOR INSULATION AND FINISH SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Composite soffit cladding of Glass-mat Gypsum Sheathing and applied coating where noted.
B. Aluminum perimeter trim and control joints.
C. Aluminum vent strips.

1.3 REFERENCES

A. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 3300.
B. Shop Drawings: Indicate joint pattern and joint details.
C. Product Data: Provide data on system materials, product characteristics, performance criteria, limitations, and finishes.
D. Samples: Submit three 12 x 12 inch size samples illustrating coating color and texture range for selection.
E. Manufacturer's Installation Instructions: Indicate preparation required, installation techniques, jointing requirements, and reinforcing required.

1.5 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this Section with minimum five years documented experience and approved by manufacturer.
B. Submit distributor letter confirming applicator's knowledge, experience, and expertise for projects of this size and difficulty.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Section 01 6000.
B. Protect adhesives and finish materials from freezing by storing in an environment recommended by manufacturer.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install finish when ambient temperature is below 40 degrees F.
B. Maintain this temperature during and 24 hours after installation of finish.

1.8 PERFORMANCE CHARACTERISTICS

A. PHYSICAL PROPERTIES (Properties shall meet or exceed the following values when tested by the methods listed.)
   1. Resistance to Accelerated Weathering:

a. Test: ASTM G23, or ASTM G53
b. Test Period: 2000 hours exposure to 120 minutes cycles of light and water spray.
c. Results: No adverse effect. No cracking or flaking.

2. Resistance to Wind Driven Rain:
   a. Test: Federal Specification TT-C-555 B.
   b. Result: No visible leaks, no dampness. Weight gain not significant.
3. Resistance to Salt Fog:
   a. Test: ASTM B117.
   b. Test Period: 500 hours.
   c. Result: No cracking. No adverse effects.
4. Resistance to Freeze/Thaw after Immersion:
   a. Test: 4 Days immersion, then 60 freeze/thaw cycles of 2 hours each (-18 degrees F).
   b. Result: No deleterious. No cracking or splitting.
5. Resistance to Fungus (Mildew):
   a. Test: MIL Standard 810B, Method 508.
   b. Result: No growth supported.
6. Abrasion Resistance:
   a. Test: ASTM D968. Sample impinged by 500 liters of standard Ottawa sand.
   b. Result: No cracking. No damage. No breakthrough of coating.
7. Resistance to Humidity and Moisture:
   a. Test: Federal Test Standard 141, Method 6201.
   b. Result: No cracking, blistering, delamination. Bond remained intact. Exterior softens during last 7 days, but hardens after removal from test chamber and air dried.
8. Water Vapor Transmission:
   a. Test: ASTM E96, Procedure B, Water Method.
   b. Result: 6.06 Grains/hr.sq.ft. (15.25 Perm).

B. FIRE TEST PERFORMANCE

1. Resistance to Large Scale Vertical Fire:
   a. Test Modified ASTM 108.
   b. Results:
      1) The removal of a 4” x 24” section of Exterior Finish to expose the Expanded Polystyrene Foam core does not adversely affect the fire performance of the System.
      2) Flaming within the core is confined to the opening and does not spread within the wall cavity.
      3) When tested with the coating intact, the System produces a maximum flame height of 6 feet.
      4) The intact Base Coat and Exterior Finish are able to prevent fire involvement of the EPS Foam Core.
      5) In both tests, ignition of the sample is minimal and produces light flaming only on the surface coating in the area of discoloration.

2. Surface Burning Characteristics:
   a. Test: ASTM E84.
   b. Result:
      1) 3.01 Base:
         Flame Spread Index = 0
      2) 3.20 Finish
         Flame Spread Index = 0
         Smoke Developed Value = 5

C. STRUCTURAL TESTING
1. Resistance between studs to Impact of a 30 lb. bag from 6 foot cumulative drop height:
   a. Test: ASTM E695, EIMA Guide, Section C.2.
   b. Result: No visible damage of coatings. Negligible deformation.
2. Resistance to Impact of a Falling Tup:
   a. Test: ASTM D3029 Method F, Tup Geomety FB.
   b. Result: No cracking, slight dent at 1.5 ft.-lbs.
3. Falling Ball Impact Resistance:
   a. Test: ASTM D1037.
   b. Results: No cracking up to 92 inch pounds.
4. Resistance to Uniform Static Air Pressure Difference Positive and Negative Wind Load:
   a. Test: ASTM E330, with 5 min. duration at each load per ASTM E72.
   b. Result: No physical damage after load applied to the exterior or the interior of the panels, maximum deflection 0.854 inches under 150 psf negative load for 5 minutes.
5. Resistance to Transverse Load:
   a. Test: ASTM E72.
   b. Result: No damage. No deformation shown after loads applied to the exterior or interior of panels, maximum mid span deflection measured 0.641 inches for 208.50 psf negative load for 5 minutes.
6. Flexural Strength:
   a. Test: ASTM C203.
   b. Result: Highly flexible. No cracks. Flexural strength: 60 psi. Apparent modulus of Elasticity: 3310 psi.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS ARE:
A. Dryvit Systems, Inc.
B. Senergy, Inc.
C. Sto Industries, Inc.

2.2 MATERIALS
A. Glass-mat Gypsum Sheathing: Treated gypsum core combined with fiberglass face and back, complying with ASTM C1177; Thickness 5/8

inch; as manufactured by USG, Georgia Pacific or Certainteed; and as acceptable to coating manufacturer.

B. Primer/Adhesive: As recommended by manufacturer.

C. Coated Reinforcement: Glass fiber mesh, woven, treated for improved bond with coating; intermediate (not less than 9.55 oz. per square yard).

D. Base Coat Materials: System manufacturer's standard, factory blended dry formulation of Portland cement, dry polymer admixture and inert fillers to which only water is added at the job site.

E. Finish Coat Materials: System manufacturer's standard mixture complying with the following requirements:

1. Factory-mixed formulation of polymer emulsion admixture, color fast mineral pigments, sound stone particles and fillers.

2.3 ACCESSORIES

A. Insulation Fastening: Threaded coated fasteners with washers.

B. Perimeter Trim and Control Joints: Aluminum with attachment flanges, to suit application as manufactured by Fry Reglet, or equal; suitable for field painting to match soffit color.

C. Soffit Vent: Fry Reglet or equal, aluminum, EIFS soffit vent, PCS- 75-V-300, 3 inches wide, miter corners and provide end closures as required; suitable for field painting to match soffit color.

D. Sealant Materials: As recommended by coating manufacturer and specified in Section 07 9000.

E. Seal Tape: Open celled, high quality polyester polyurethane foam; impregnated with neoprene rubber; self adhesive and precompressed.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examination of Substrate:

1. Prior or installation of the SYSTEM, the substrate shall be examined by the applicator as follows:
   a. The substrate shall be of a type approved by casting manufacturers.
   b. The substrate shall be examined for soundness, such as tightness of connections, crumbling or looseness of surface, voids and projections, etc.
   c. The substrate shall be examined for dimensional tolerances per this specification.
   d. The substrate surface shall be free of foreign materials such as oil, dust, dirt, form release agents, paint, wax, water, frost, etc.
2. The Architect-Engineer and Construction Manager shall be advised of all discrepancies. Work shall not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION - TRIM

A. In general, installation shall conform to this specification and manufacturer's written recommendations.

B. Square edge, drip edge of diaphragm jointing material shall be fastened solidly to substrate and/or framing at 10 to 12 inches on center.

3.3 INSTALLATION – GLASS MAT GYPSUM BOARD

A. Install in accordance with manufacturer's instructions.
B. Place boards in a method to maximize tight joints. Butt edges and ends tight to adjacent board and to protrusions.
C. Secure boards to substrate by using Manufacturer's recommended adhesive and by mechanical recessed attachment and plugged with material to achieve a continuous flush insulation surface.

3.4 INSTALLATION – COATING

A. Install primer/adhesive, coating and reinforcement in accordance with manufacturer's instructions.
B. Apply primer/adhesive to a minimum thickness of 3/32 inch and fully embed reinforcement, wrinkle free.
C. Lap reinforcement edges and ends 2-1/2 inches minimum.
D. Install perimeter trim and control joints.
E. Apply finish to a minimum thickness of 3/32 inch matching approved sample for color texture.
F. Apply sealant at finish perimeter and control joints in accordance with Section 07 9000.
G. Finish coat thickness:
    1. Minimum 1/16"
    2. Maximum ¼"
H. Finish Pattern: Final texture shall be manufacturer's standard light sand finish as acceptable to architect.

3.5 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Section 01 5000.
B. Do not permit finish surface to become soiled or damaged.

3.6 FIELD QUALITY CONTROL

A. An authorized Manufacturer's Representative shall visit the site at the beginning, middle, and end of work of this section.
B. Manufacturer's Representative shall certify in writing that the applicator is using the specified materials, in their proper way, for an acceptable finish at the time of all his unannounced visits.

3.7 CLEAN – UP

A. Remove all debris due to work of this section.
B. Clean adjacent surfaces, as required.
C. Give the Owner a minimum of one (1) 5 gallon pail of finish at completion of project.

END OF SECTION 07 2419

SECTION 07 4213
METAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections apply to this Section.

1.2 DESCRIPTION OF WORK

A. Extent of Wall Panel System is shown on drawings and by provisions of this Section.

B. Types of Wall Panel System required include the following:
   1. Metal Wall Panels over metal framing wall system consisting of cold formed metal framing, sheathing and air infiltration barrier.
   2. Metal Wall Panels over masonry wall system consisting of masonry, metal furring and rigid insulation.
   3. Metal Wall Panels over steel screen wall framing above roof for mechanical equipment screens.

C. Coordinated Installation: Except as otherwise indicated, perform system work and the following associated units of work as a single integrated unit of work, without division of responsibility between separate Installers (Single-Installer responsibility required):
   1. Exterior profiled panels.
   2. Covers, closures and similar border and filler items shown as metal panel work.
   3. Associated sealants, joint fillers, gaskets and flashings including sealing at entire perimeter of metal panel system.
   4. Anchorages, shims, fasteners, support brackets, expansion devices, accessories and similar elements for components of the metal panel system including furring, bracing or other support members for attachment to supporting substrate.

D. Related Work Specified Elsewhere:
   1. Metal Flashing and Trim: Section 07 6200.
   2. Joint Sealers: Section 07 9000.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide manufacturer's metal panel system adapted to applications indicated that comply with performance requirements specified as demonstrated by testing manufacturer's corresponding system in accordance with AAMA 501, "Methods of Test for Metal Curtain Walls".

B. Provide manufacturer's metal panel system complying with AAMA 621,"Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized and Zinc-Aluminum Coated Steel Substrates.

C. Structural Performance: Design, engineer, fabricate and install metal panel system to withstand the effects of wind loads, thermal movements, building and anchorage movements and other conditions without exceeding limitations for deflection, material failure or permanent deformation of structural members.

D. Load-Bearing Strength (Wind Loads): Provide manufacturer's metal panel system adapted to applications indicated which have been tested in accordance with ASTM E 330 to withstand uniform pressures using 90 MPH winds, Exposure B, Iw = 1.15.

E. Deflections and Thermal Movements: Provide manufacturer's metal panel system adapted to applications indicated which are capable of withstanding building movement including drift, vertical deflection and construction shrinkage, weather

exposure including wind loading, and erection tolerances within the following limitations:

1. Normal to wall deflection of 1/200 of span or 3/4 inch, whichever is less.
2. Thermal movements resulting form an ambient temperature range of 120 degrees F, which may result in a metal surface temperature range of 180 degrees F within the metal panel system.
3. Successful performance without evidence of any of the following:
   a. Panel separation or buckling.
   b. Excessive stresses on structural elements or fasteners and permanent deformation of supporting framing members in excess of L/1000.
   c. Failure of seals, reduction of performance or other detrimental effects.

F. Unacceptable Conditions: Noise or vibration created by thermal movement, structural movement or wind; thermal movement transferred to building structure; and loosening, weakening or failure of fasteners, attachments or components.

G. Joints: Carefully match all exposed work to produce continuity of line and design with all joints accurately aligned in all planes. Locate vertical and horizontal joints in metal panel system only as shown.

H. Codes: Comply with applicable provisions of Building and Fire Codes.

1.4 QUALITY ASSURANCE

A. Design Concept: The drawings indicate sizes, profiles and dimensional requirements of metal panel system required. Minor deviations in dimensions and profiles may be accepted, when, in the Architect's sole judgement, such deviations do not materially detract from the design concept.

B. Single Source Responsibility: Provide Metal Wall panel system for the project that is the product of a single manufacturer.
   1. It is the responsibility of manufacturer to coordinate design of in-place system to comply with performance criteria.
   2. Responsibility shall also include design, furnishing and installation of anchor assemblies, support framing, related connections and/or fasteners, as required for full compliance with specified criteria. Provide template drawings which show exact location and type of embedment items to be furnished to other trades.

C. Installer Qualifications: Engage an Installer who has not less than five years demonstrated experience of successfully installed metal panel systems similar in size and character to this project. Submit a list of at least five completed projects of similar nature and scope; list project name, location and Architect.

D. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with the AWS "Standard Qualification Procedure."
   1. Provide certification that welders to be employed in work have satisfactorily passed AWS Qualification Tests.
   2. If recertification of welders is required, retesting will be Contractor's responsibility.

E. Standards: Comply with applicable standards of building products industry and construction industry for selection of materials, fabrication of components, assembly and installation/erection of metal panel system or with more explicit and stringent requirements where so specified.
   1. Comply with applicable provisions of the "Metal Curtain Wall, Window, Storefront and Entrance Guide Specifications manual" by AAMA.

F. Pre-Installation Conference: Prior to beginning work of this Section, require that metal panel manufacturer and sealant contractor meet at project site to review procedures, schedules and coordination of metal panel work.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, recommendations and standard details for metal panel work including fabrication, finishing, accessories and other components of the work.
B. Shop Drawings: Submit shop drawings for the fabrication and installation of metal panel units and associated components of the work. Include wall elevations at ¼ inch scale, typical unit elevations at 1 inch scale, and full size detail sections of every typical composite member. Show anchors, joint system, expansion provisions and other elements not included in manufacturer's standard data.
C. Samples for Verification Purposes: Submit 6 inch square samples of each required type and color of finish on sheet as required for metal panel units. Where color or texture of finish will vary for the work, include 2 or more pieces in each sample to show limits of such variations.
D. Test Reports: Submit certified test reports for required tests, recording dates, locations, methods of testing, test results and interpretation of results.
E. Qualification Data: Submit written information to establish installer qualifications, demonstrating capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information as required.
F. Maintenance Manual: Submit three copies of bound maintenance manual for metal panel work. Include instructions for cleaning, repair and general maintenance of panels. Include manufacturer's data for all products used in metal panel work.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver metal panels and related components so they will not be damaged or deformed. Package metal panels for protection against transportation damage.
B. Exercise care in unloading, storing and erecting metal panels to prevent bending, warping, twisting and surface damage.
C. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight ventilated covering. Store metal panels so that they will not accumulate water. Do not store metal panels in contact with other materials that might cause staining, denting or other surface damage.

1.7 WARRANTY

A. Submit written warranty executed by the Metal Panel Manufacturer and Installer agreeing to repair or replace defective materials and workmanship during the warranty period. Defective materials and workmanship is hereby defined to include evidence of abnormal deterioration, aging or weathering of the work, structural failure of components resulting from exposure to normal loads and forces, deterioration or discoloration of finishes in excess of normal weathering and aging, and failure of the work to fulfill other specified performance requirements.
   1. The warranty period is five (5) year period.
B. This warranty shall not deprive the Owner of other rights or remedies that the Owner may have under provisions of the Contract Documents and is in addition to and runs concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 BASIS-OF-DESIGN STANDARD

A. Subject to compliance with requirements, the design standards are:
   1. Field Panels (wall and mechanical screen): Centria Concept Series, CS-260 or CS-260E, 12 inch high, 3 rib, 0.875 inch thickness, color Champagne Gold XL.
   2. Accent Panels (wall only): Centria Concept Series, CS-260 or CS-260E, 12 inch high, 3 rib, 0.875 inch thickness, color Grey Velvet mica.

2.2 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements and matching design standard for finish, color and profile as acceptable to Architect:
   1. Berridge
   2. Centria

2.3 METAL PANELS, GENERAL

A. Provide manufacturer's standard metal panel system adapted to applications indicated complying with system performance requirements.
B. Provide metal panels with exposed surfaces free of visible imprinting due to fabrication including seam and roller marks, except as otherwise specified. Finish surfaces for uniform visual appearance, free from stains, discolorations or other imperfections as acceptable to Architect.
C. Comply with requirements for dimensions, profiles, modularity and joinery to design concept as determined solely by Architect.

2.4 METAL PANEL MATERIALS

A. Metallic-Coated Steel Face Sheet: Coil-coated, ASTM A 755/A 755M.
   1. Galvanized Steel Sheet: ASTM A 653/A 653M, G90.
   2. Face Sheet: Minimum 0.036 inch/20 gage (0.91) nominal uncoated thickness.
   3. Surface: Smooth

2.5 MISCELLANEOUS MATERIALS:

A. Assembly and Installation Accessories: Provide manufacturer's standard fasteners, brackets, clips, anchoring devices, furring strips, spacers, flashings, closures, adhesives, joint sealers, expansion joints and other components required for a complete and permanently weatherproof installation. Use materials which are noncorrosive, nondeteriorating and compatible with metal panels.
B. Secondary Framing Components: Cold-formed metal framing, galvanized G90, of size, shape and thickness as required to accommodate design and structural requirements.
C. Mitered corners: Prefabricated, structurally bonded, horizontal interior and exterior trimless corners, matching metal wall panel material, profile and finish.
D. Fasteners, General: Provide type and sizes shown, or as required for proper support and performance, fabricated in compliance with FS SS-S-92 of nonmagnetic stainless steel or other nonferrous metal which is electrolytically compatible with the materials being fastened.
   1. Bolts and nuts of zinc-coated steel, complying with ASTM A 307, Grade A, may be used for concealed assembly and anchorage in locations not exposed to the weather, provided no possibility of electrolytic action is present.
E. Bituminous Coating: Cold-applied asphalt mastic, complying with SSPC Paint 12, compounded for application in a 30-mil coating.
F. Slip-Joint Linings: Provide plastic sheets, spacers or bearing pads as required to ensure free movement between surfaces where expansion and deflection movements are intended. Provide fluorocarbon resin or equivalent plastic units of the sizes and thicknesses recommended by the manufacturer to permanently prevent "freeze-up" of joints.

2.6 FABRICATION

A. Fabricate and finish metal panel system at factory by manufacturer's standard procedures and processes, as required to fulfill indicated performance requirements which have been demonstrated by laboratory testing. Comply with indicated profiles and dimensional requirements and with structural requirements.

1. Complete fabrication and assembly at factory to the greatest extent possible so as to minimize field cutting, splicing, fastening, seating, finishing and similar work. Disassemble only as necessary for shipment and erection.
2. Maintain provisions for expansion and movement as required.

B. Apply bituminous coating or other permanent separation materials on concealed metal panel surfaces where metal panels would otherwise be in direct contact with substrate materials which are noncompatible or could result in corrosion or deterioration of either material or finishes.

C. Comply with industry standards for assembly and fabrication work as required, using welding system and rods for exposed metal work which will provide the closest possible color and texture match with materials being joined. Grind exposed welds smooth, using clean grinding wheels of a type which will not result in stains or discolorations.

2.7 METAL FINISH

A. General: Comply with NAAMM "Metal Finishes Manual" for recommendations and designations of finishes.

B. Apply coatings after forming and fabricating metal panels as required by coating process and as required for maximum coating performance capability. Protect coating either by application of strippable film or by packing plastic film or other suitable material between metal panels in a manner to protect the finish properly. Furnish air-drying spray finish in matching color for touch-up.

C. Field Panels and Mechanical Screen: Three coat fluoropolymer metallic system consisting of 0.2 mil primer with 0.8 mil 70% PVDF fluoropolymer color coat containing metal flakes, and a 0.5 mil 70% PVDF fluoropolymer clear coat.

D. Accent Panels: Two coat fluoropolymer mica system consisting of 0.25 mil primer with 0.8 mil 70% PVDF fluoropolymer color coat providing a pearlescent appearance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structures and conditions under which metal panels are to be installed. Notify Construction Manager in writing of conditions detrimental to proper and timely completion of work. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 PREPARATION

A. Coordinate with other work by furnishing shop drawings, inserts and similar items at appropriate times for proper sequencing of construction without delay. Verify dimension of supporting structure and other elements which precede metal panel work before fabrication of required components; however, do not delay the work. Provide for erection tolerances corresponding with specified tolerances for other work where field measurements cannot be obtained.

3.3 INSTALLATION

A. Comply with manufacturer's instructions for protection, handling and installation of fabricated metal panel components, with particular attention and care in preservation of applied finishes.

B. Do not install component parts which are defective including warped, bowed, dented, abraded or otherwise damaged. Remove and replace members which have been damaged during installation or thereafter before time of final acceptance.
C. Co not cut, trim, weld or braze component parts during erection in any manner which would damage the finish, decrease strength, result in a visual imperfection, or result in a failure in performance of the metal panels. Return component parts which require alteration to the shop for refabrication, if possible, or for replacement by new components.
D. Install component parts level, plumb, true to line and with uniform joints and reveals. Secure to structure with non-staining and non-corrosive shims, anchors, fasteners, spacers and fillers. Use erection equipment which will not mar or stain finished surfaces, and will not damage the component parts in any way.
E. Provide secondary framing components where required to accommodate design or where necessary due to spacing of primary structural framing. Install secondary framing components per wall panel manufacturer's recommendations.
F. Anchor component parts securely in place as shown by bolting, welding or other permanent mechanical attachment system which will comply with performance requirements and permit movements which are intended or necessary. Install slip-joint linings wherever possible to ensure movement as intended or necessary.
    1. Do not expose any fasteners to view.
G. Apply a bituminous coating of approximately 30-mil dry film thickness or other suitable permanent separator on concealed contact surfaces of dissimilar materials before assembly or installation, wherever there is the possibility of corrosive or elecrolytic action.
H. Where welding is required for exposed ferrous work during the erection of the metal panel assembly, comply with recommendations of the AWS for the particular metals and alloys being welded. Use methods and welding rods which will not distort the members. Grind exposed surfaces smooth, using wheels and compounds which are free or iron and other substances which would result in stains or discoloration of the surfaces. Restore finishes after welding and grinding.
I. Do not exceed the following reaction tolerances: 1/8 inch deviation from plumb or level in 10 feet; 3/8 inch maximum deviation, at any point, from calculated theoretical location; 1/16 inch maximum offset of flush alignments, 1/8 inch maximum offset if separated by more than 2 inches spacing or by protruding member.

3.4 ADJUSTING AND CLEANING

A. Clean metal panel system promptly after erection, allowing for nominal curing of liquid sealants.
B. Maintain metal panel system in a reasonably clean condition throughout construction period, so that they will be without deterioration or damage (other than normal weathering) at time of acceptance. Select methods of cleaning which will promote achievement of uniform appearance and stabilized colors and textures for materials that weather or age with exposure.
C. At time of opening, clean metal panel system thoroughly. Demonstrate proper cleaning methods and materials to the Owner's maintenance personnel.

3.5 PROTECTION

A. Advise Construction Manager of proper and adequate procedures for protection and cleaning during the remainder of the construction period so that metal panel system will be without damage and deterioration at the time of acceptance.
B. Restore finishes damaged during construction period so that no evidence of correction work remains. Return components to the shop that cannot be restored in

the field; make required alterations and refinish entire component or provide new components.

END OF SECTION 07 4213

SECTION 07 4243
COMPOSITE WALL PANELS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section includes metal-faced composite wall panels.

1.3 PERFORMANCE REQUIREMENTS

A. 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.

B. 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. Design Factors:
   a. Wind Speed: 90 mph.
   b. Exposure C.
   c. Building height: 60 ft.
   d. Importance Factor: 1.0.
2. Deflection Limits: Metal 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.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation layouts of metal-faced composite wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish among factory-, shop-, and field-assembled work.

C. Samples: For each type of exposed finish required.

D. Delegated-Design Submittal: For metal-faced composite wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data and calculations signed and sealed by the qualified professional engineer responsible for their preparation.

E. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other.

F. Product test reports.

G. Maintenance data.

H. Samples of special warranties.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1.6 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. Warranty Period: Two years from date of Substantial Completion.

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 Finish:
      a. Manufacturer’s standard 20 year Kynar 500 finish.
   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.

B. Panel Sealants: ASTM C 920.

2.2 MISCELLANEOUS METAL FRAMING

A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, 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 or Channels: 0.079-inch nominal thickness.

2.3 MISCELLANEOUS MATERIALS

A. Aluminum Extrusions: ASTM B 221.

B. 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-faced composite wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

2.4 METAL-FACED SOLID CORE COMPOSITE WALL PANELS

A. General: Provide factory-formed and -assembled, metal-faced 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.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Alcan Composites USA Inc.; Alucobond.
   b. Alcoa Inc.; Reynobond PE
   c. CENTRIA Architectural Systems..

B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch-thick, anodized aluminum sheet facings.

1. Panel Thickness: 6mm.
2. Core: Standard.
3. Exterior Finish: Clear anodized.

C. Attachment System Components: Formed from extruded aluminum.

1. Include manufacturer's standard perimeter extrusions with integral weather stripping, panel stiffeners, panel clips and/or anchor channels, per approved shop drawings and product data.

2.5 ACCESSORIES

A. Wall Panel Accessories: Provide components required for a complete metal-faced composite wall panel assembly including trim, copings, fascia, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, vents and similar items. Match material and finish of metal-faced composite wall panels unless otherwise indicated.

2.6 FABRICATION

A. General: Fabricate and finish metal-faced 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 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 Wall Panels: Factory form panels in a continuous process with no glues or adhesives between dissimilar materials, or batch process by laminating each sheet using 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.

PART 3 - EXECUTION

3.1 PREPARATION

A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and metal-faced composite wall panel manufacturer's written instructions.

3.2 METAL-FACED WALL PANEL INSTALLATION

A. 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.

B. Clip Installation: Attach panel clips to supports at each metal-faced composite wall panel joint at locations, spacings, and with fasteners recommended by manufacturer. Attach routed-and-returned flanges of wall panels to panel clips with manufacturer's standard fasteners.
   1. Seal horizontal and vertical joints between adjacent panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants."

C. Track-Support Installation: Provide manufacturer's standard horizontal and vertical tracks that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install support system at locations, spacings, and with fasteners recommended by manufacturer. Attach panels to wall by interlocking tracks with perimeter extrusions attached to wall panels. Fully engage integral gaskets and leave horizontal and vertical joints with open reveal.
   1. Attach routed-and-returned flanges of wall panels to perimeter extrusions with manufacturer's standard fasteners.
   2. Attach flush wall panels to perimeter extrusions by engaging panel edges and by attaching with manufacturer's standard structural silicone adhesive.
   3. Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.
   4. Do not apply sealants to joints unless otherwise indicated on Drawings.

D. Subgirt-and-Spline Installation: Provide manufacturer's standard subgirts and splines that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install support system at locations, spacings, and with fasteners recommended by manufacturer. Attach wall panels by interlocking perimeter extrusions attached to routed-and-returned flanges of wall panels with subgirts and splines. Fully engage integral subgirt-and-spline gaskets and 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.

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, non-accumulative, 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.

END OF SECTION 07 4243

SECTION 07 5323
EPDM ROOFING - FULLY ADHERED

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Insulation, membrane roofing, base flashings, and counter flashings.
   1. Membrane manufacturer shall coordinate and be singularly responsible for the insulation, tapered insulation, flashing, and membrane installation, compatibility, and water tightness.

1.3 REFERENCES

A. ASTM C177 - Test Method for Steady-State thermal Transmission Properties by Means of the Guarded Hot Plate.
B. ASTM C578 - Preformed, Cellular Polystyrene Thermal Insulation.
C. ANSI/ASTM D412 - Rubber Properties in Tension.
D. ANSI/ASTM D746 - Brittleness Temperature of Plastics and Elastomeric by Impact.
E. ASTM D624 - Rubber Property - Tear Resistance.
F. ASTM D822 - Practice for Operating Light and Water-Exposure Apparatus (Carbon-Arc) Type for Testing Paint, Varnish, Lacquer, and Related Products.
G. ASTM D1004 - Initial Tear Resistance of Plastic Film and Sheeting.
H. ASTM D2240 - Rubber Property - Durometer Hardness.
I. ASTM E96 - Water Vapor Transmission of Materials.
J. Factory Mutual Engineering & Research Corporation (FM) - Roof Assembly Classifications.
K. FS HH-I-551 - Insulation Block and Boards, Thermal (Cellular Glass).
L. FS LLL-I-535 - Insulation Board, Thermal (Cellulosic Fiber).
M. National Roofing Contractors Association (NRCA) - Roofing and Waterproofing Manual.
N. Underwriters Laboratories (UL) - Fire Hazard Classifications.

1.4 SYSTEM DESCRIPTION

A. Elastomeric Sheet Membrane Roofing System: Composite White on Black, non-reinforced membrane system adhesive applied over tapered insulation (1/4” per foot slope minimum pitched for positive drainage) with staggered joints.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 3300.
B. Shop Drawings: Indicate setting plan for tapered insulation, joint or termination detail conditions, and conditions of interface with other materials.

C. Product Data: Provide characteristics on membrane materials, flashing materials, and insulation.
D. Samples: Submit two 6 x 6 inches in size illustrating insulation.
E. Manufacturer's Installation Instructions: Indicate special precautions required for seaming the membrane.
F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
G. Manufacturer's Field Reports: Submit under provisions of Section 01 4000.
H. Reports: Indicate procedures followed; ambient temperatures, humidity and wind velocity during application.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with three years documented experience.
B. Applicator: Company specializing in performing the work of this section with three years documented experience and approved by system manufacturer.
C. Work of this section to conform to NRCA Roofing and Waterproofing Manual and manufacturer's instructions, unless more stringent criteria is specified here-in.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for roof assembly fire hazard requirements.
B. Installed by a Manufacturer's Certified Contractor.
C. Factory Mutual Engineering & Research Corporation (FM): Roof Assembly Classification, of Class 1 Construction, intent is to follow the wind uplift requirements of I-60, in accordance with FM Construction Bulletin 1-28.
D. Manufacturer shall certify that before, during, and after membrane is complete that manufacturer's instructions were followed.
E. This Contractor shall be responsible for testing mechanical anchors into deck for base layer of insulation; minimum pull out resistance shall be 300 lbs. per fastener.
F. For top layer of insulation follow roofing manufacturer's adhesive applied insulation system to meet I-60 requirements.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 01 6000.
B. Deliver products in manufacturer's original containers, dry, undamaged, seals and labels intact.
C. Store products in weather protected environment, clear of ground and moisture.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not apply roofing membrane during inclement weather and when ambient temperatures are below 40 degrees F.
B. Do not apply roofing membrane to damp or frozen deck surface.

C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during same day.

1.10 COORDINATION

A. Coordinate the work with installation of associated metal flashings, as the work of this section proceeds.
B. Coordinate the work with Owner's separate Roofing Consultant.
C. Membrane manufacturer shall have singular responsibility for water tightness of roof; including insulation, membrane, and flashing metals.

1.11 WARRANTY

A. Provide 15 year total warranty.
B. Warranty: Cover damage to building resulting from failure to prevent penetration of water; including labor and material of roofing system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Carlisle Syntec Systems.
B. Firestone.

2.2 MEMBRANE AND ASSOCIATED MATERIALS

A. Membrane: EPDM; .060 inches thick, (60 mil), non-reinforced, 90 inches wide minimum roll width; composite white on black color; conforming to the following criteria:

Properties:	Test:	Results:
Tensile Strength	ANSI/ASTM D412	1305 psi
Elongation:	ANSI/ASTM D412	300%
Hardness - Shore A:	ASTM D2240	65 ± 10
Tear Strength:	ASTM D624	150 lbs/inch minimum
Moisture Vapor Perms:	ASTM E96	2.0
0 Zone resistance:	ASTM D1149	No cracks
Low Temp Brittleness:	ANSI/ASTM D746	-49° F

B. Seaming Materials: As recommended by membrane manufacturer.

2.3 ADHESIVE MATERIALS

A. Surface Conditioner: Manufacturer's recommended type, compatible with membrane.
B. Membrane Adhesives: As recommended by membrane manufacturer.
C. Insulation Adhesive: As recommended by insulation manufacturer.
D. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

2.4 ACCEPTABLE MANUFACTURERS (POLYISOCYANURATE INSULATION AND TAPERED INSULATION)

A. Atlas Energy Polyisocyanurate Products

B. Celotex
C. Manville
D. NRG's

2.5 FLASHINGS

A. Flexible Flashings: Same material as membrane, EPDM; White on Black color; as manufactured by membrane manufacturer.
B. Counter Flashings: Prefinished aluminum, as specified in Section 07 6200.
C. Prefabricated Roof Specialties: Manufacturer's standard preformed boots and accessories.

2.6 ACCESSORIES

A. Insulation Joint Tape: Asphalt treated glass fiber reinforced; 6 inches wide; self adhering.
B. Insulation Fasteners: Appropriate for purpose intended and approved by Factory Mutual and system manufacturer; length required for thickness of material with metal washers; as manufactured by NTB or approved equivalent.
C. Sealants: As recommended by membrane manufacturer.
D. Traffic pads: molded rubber with slip resistant surface, factory rounded corners, approximately 30 inch x 30 inch x 3/16 inch. Color to match roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.
B. Verify deck is supported and secure.
C. Verify deck is clean and smooth, free of depressions, waves, or projections, properly sloped to drains.
D. Verify deck surfaces are dry and free of snow or ice.
E. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, and wood nailing strips and reglets are in place.
F. Verify compatibility of treated wood with roofing materials and attachment.

3.2 MEMBRANE APPLICATION

A. Apply membrane and primer in accordance with manufacturer's instructions.
B. Roll out membrane and let membrane relax for a minimum of 30 minutes.
C. Fold Back membrane and apply adhesive to both membrane and insulation top surface.
D. After adhesive becomes tacky roll out membrane, free from air pockets, wrinkles, or tears. Firmly press sheet into place without stretching.
E. Overlap edges and ends and seal by solvent welding, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
F. Shingle joints on sloped substrate in direction of drainage.

G. Extend membrane up and over the top of curbs and parapets, extend down vertical face over nailers, and seal tight.
H. Seal membrane around roof penetrations. Use preformed flashings.

3.3 FLASHINGS AND ACCESSORIES

A. Apply flexible flashings to seal membrane to vertical elements.
B. Secure to nailing strips at 4 inches on center.
C. Coordinate installation of roof drains and related flashings.
D. Seal flashings and flanges of items penetrating membrane.
E. Provide traffic pads where indicated on drawings, installed in accordance with manufacturer's instructions. If not indicated on drawings, provide traffic pads around all mechanical equipment, from roof access point to equipment, and between pieces of equipment.

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01 4000. Manufacturers representative shall certify roof material installation to be per recommendations and watertight.
B. Coordinate with Owner's Independent Roofing Consultant, per specification Section 01 4900.
C. Correct identified defects or irregularities.
D. Require site attendance of roofing and insulation materials' manufacturers during installation of the Work.

3.5 CLEANING

A. In areas where finished surfaces are soiled by Work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.
B. Repair or replace defaced or disfigured finishes caused by Work of this section.
C. Clean excess adhesive off membrane as soon as practical to avoid staining of white surface.

3.6 PROTECTION

A. Protect building surfaces against damage from roofing work.
B. Where traffic must continue over finished roof membrane, protect surfaces per manufacturer's recommendations.

END OF SECTION 07 5323

SECTION 07 6200
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 1 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS
A. Division 13, Section "Pre-Engineered Buildings" for gutters, downspouts, and flashings as part of the pre-engineered building system.

1.3 SUMMARY
A. This Section includes sheet metal flashing and trim not covered in other sections.
B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 7 Section "Joint Sealants" for elastomeric sealants.

1.4 PERFORMANCE REQUIREMENTS
A. General: Install sheet metal flashing to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.
B. Fabricate and install flashings to comply with recommendations of FM Loss Prevention Data Sheet 1-49 for the applicable wind zone:

1.5 SUBMITTALS
A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
B. Product Data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.
C. Shop Drawings of each item specified showing layout, profiles, methods of joining, and anchorage details.
D. Qualification data for firms and persons specified in the "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.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: Engage an experienced Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.7 PROJECT CONDITIONS
A. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation. Ensure best possible weather resistance, durability of Work, and protection of materials and finishes.

PART 2 - PRODUCTS

2.1 METALS
A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability of alloy and temper designated below:

1. Factory-Painted Aluminum Sheet: ASTM B 209 (ASTM B 209M), 3003-H14, with a minimum thickness indicated.

2.2 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Fasteners: Same metal as sheet metal flashing or other noncorrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.
B. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.
C. Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Division 7 Section "Joint Sealants."
D. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; noncorrosive; size and thickness required for performance.

2.3 FABRICATION, GENERAL

A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.
B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
C. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
D. Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.
E. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.
F. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
    1. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

2.4 SHEET METAL FABRICATIONS

A. General: Fabricate sheet metal items in thickness or weight needed to comply with performance requirements but not less than that listed below for each application and metal.
    1. Two piece cap flashing assembly and drip edge: Fabricate from 0.032 inch thick, aluminum.
    2. Copings, fascias, gutters and downspouts: Fabricate from 0.040 inch thick aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that Work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal 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 weatherproof.

B. Install exposed sheet metal Work 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. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant.
   1. Use joint adhesive for nonmoving joints specified not to be soldered.

D. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with separation as recommended by manufacturer.

E. Roof-Penetration Flashing: Coordinate roof-penetration flashing installation with roofing and installation of items penetrating roof. Install flashing as follows:
   1. Seal and clamp flashing to items penetrating roof.
   2. Pitch pockets are <u>not</u> acceptable.

3.3 CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

END OF SECTION 07 6200

SECTION 07 7200
ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes steel doors and frames.
   1. Roof hatches.

B. This Section includes steel doors and frames.
   1. Division 5 Section "Metal Fabrications" for metal ships' ladder, and framing for roof hatches.
   2. Division 6 Section "Rough Carpentry" for and wood nailers.

1.3 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: Show fabrication and installation details for roof accessories. Show layouts of roof accessories including plans and elevations. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other work.

C. 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.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify required openings for each type of roof accessory by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 COORDINATION

A. Coordinate layout and installation of roof accessories with interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

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, manufacturers listed in other Part 2 articles.

2.2 METAL MATERIALS

A. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coated.

2.3 MISCELLANEOUS MATERIALS

A. Polyisocyanurate Board Insulation: ASTM C 1289, 1 inch thick.

B. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches thick.

C. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.

D. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.

E. Elastomeric Sealant: ASTM C 920, polyurethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

2.4 ROOF HATCHES

A. Roof Hatches: Fabricate roof hatches with insulated double-wall lids and insulated double-wall curb frame with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints. Provide continuous weathertight perimeter gasketing and equip with corrosion-resistant or hot-dip galvanized hardware.

1. Manufacturers:
   a. Babcock-Davis; a Cierra Products Inc. Company.
   b. Bilco Company (The).
   c. Custom Curb, Inc.
   d. Dur-Red Products.
   e. Milcor Inc.; a Gibraltar Company.
   f. Nystrom, Inc.
2. Loads: Fabricate roof hatches to withstand 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loads.

3. Type and Size: Single-leaf lid, 30 by 36 inches.
4. Curb and Lid Material: Galvanized steel sheet, 0.079 inch thick.
5. Insulation: Polyisocyanurate board.
6. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.
7. Exterior Curb Liner: Manufacturer's standard metal liner of same material and finish as metal curb.
8. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
9. Fabricate units to minimum height of 16 inches unless otherwise indicated.
10. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate hatch curbs with height tapered to match slope to level tops of units.
11. Hardware: Galvanized steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.

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 work.
   1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored and is ready to receive roof accessories.
   2. Verify dimensions of roof openings for roof accessories.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Install roof accessories to fit substrates and to result in watertight performance.

C. 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 manufacturer.

D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

E. Roof Hatch Installation:

1. Check roof hatch for proper operation. Adjust operating mechanism as required. Clean and lubricate joints and hardware.

F. Seal joints with elastomeric sealant as required by manufacturer of roof accessories.

3.3 TOUCH UP

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.4 CLEANING

A. Clean exposed surfaces according to manufacturer's written instructions.

END OF SECTION 07 7200

SECTION 07 8413
PENETRATION FIRESTOPPING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Extent of firestopping is as required to maintain fire ratings at partitions and floor construction.

B. Types of firestopping required include the following:

1. Penetrations through fire-resistance-rated floor construction including both empty openings and openings containing cables, pipes, ducts, conduits and other penetrating items.
2. Penetrations throughout fire-resistance-rated walls and partitions including both empty openings containing cables, pipes, ducts, conduits, and other penetrating items.
3. Penetrations through smoke barriers and construction enclosing compartmentalized areas involving both empty openings and openings containing penetrating items.
4. Sealant joints in fire-resistance-rated construction.

C. Related Work Specified Elsewhere:

1. Duct and pipe penetrations: Division 20, 21 and 23.
2. Pipe and conduit penetrations: Division 26 and 27.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. General: Provide firestopping systems that are produced and installed to resist the spread of fire, according to requirements indicated, and the passage of smoke and other gases.

B. Fire-Resistive Joint Sealants: Provide joint sealants with fire-resistance ratings indicated, as determined per ASTM E 119, but not less than that equaling or exceeding the fire-resistance rating of the construction in which the joint occurs.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide firestopping that complies with the following requirements and those specified under the “System Performance Requirements” article:

1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, Warnock Hersey, or another agency performing testing and follow-up inspection services for firestop systems that is acceptable to authorities having jurisdiction.
2. Through-penetration firestop systems are identical to those tested per ASTM E 814 under conditions where positive furnace pressure differential of at least 0.01 inch of water is maintained at a distance of 0.78 inch below the fill materials surrounding the

penetrating items in the test assembly. Provide rated systems complying with the following requirements:

a. Through penetration firestop systems products bear classification marking of qualified testing and inspecting agency.

b. Through-penetration firestop systems correspond to those indicated by reference to through penetration firestop system designations listed by UL in their 'Fire Resistance Directory,' by Warnock Hersey, or by another qualified testing and inspecting agency.

3. Fire-resistive Joint sealant systems are identical to those tested for fire-response characteristics per ASTM E 119 under conditions where the positive furnace pressure differential is at least 0.01 inch of water, as measured 0.78 inch from the face exposed to furnace fire. Provide systems comply with the following requirements.

a. Fire-Resistance Ratings of Joint Sealants: As indicated by reference to design designations listed by UL in their 'Fire Resistance Directory' or by another qualified testing and inspecting agency.

b. Joint sealants, including backing materials, bear classification marking of qualified testing and inspection agency.

B. Installer Qualifications: Engage an experienced Installer who has completed firestopping that is similar in material, design, and extent to that indicated for Project and that has performed successfully.

C. Provide firestopping products containing no detectable asbestos as determined by the method specified in 40 CFR Part 763, Subpart F, Appendix A, Section 1, "Polarized Light Microscopy."

D. Coordinating Work: Coordinate construction of openings and penetrating items to ensure that designated through-penetration firestop systems are installed per specified requirements.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each type of firestopping product required. Include data substantiating that materials comply with specified requirements.

1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building components.

B. Product certificates signed by manufacturers of firestopping products certify that their products comply with specified requirements.

C. Test Reports: Submit product test reports from, and based on tests performed by, a qualified testing and inspecting agency evidencing compliance of firestopping with requirements based on comprehensive testing of current products.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver firestopping products to Project site in original, unopened containers or packages with intact and legible manufacturer's labels, identifying product and manufacturer; date of manufacturer; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multi-component materials.
B. Store and handle firestopping materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Do not install firestopping when ambient or substrate temperatures are outside limits permitted by firestopping manufacturers or when substrates are wet due to rain, frost, condensation or other causes.
B. Ventilation: Ventilate firestopping per firestopping manufacturer's instructions.

PART 2 – PRODUCTS

2.1 FIRESTOPPING, GENERAL

A. Compatibility: Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by firestopping manufacturer based on testing and field experience.
B. Accessories: Provide components for each firestopping system that are needed to install fill materials and to comply with System Performance Requirements. Use only components specified by the firestopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire-resistance-rated systems.
C. Applications: Provide firestopping systems composed of materials specified in this Section that comply with system performance and other requirements.

2.2 FIRE RESISTANT SPRAY

A. Sprayable fire resistive mastic for use on construction joints, similar to Hilti Firestop Speed Spray.

2.3 FIRE RESISTANT JOINT SEALERS

A. General: Provide manufacturer's standard firestopping sealant, with accessory materials, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters' Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
B. Foamed-In-Place Firestopping Sealant: Two-part, foamed-in-place, silicone sealant formulated for use in a through-penetration firestop system for filling openings around cable, conduit, pipes, and similar penetrations through walls and floors:

1. Products: Subject to compliance with requirements, provide one of the following:
    a. Dow Corning Fire Stop Foam: Dow Corning Corp.
    b. Pensil 2001: General Electric Co.

C. Intumescent Latex Sealant: Single component, intumescent, latex formulation, fire-resistance ratings as required determined in accordance with ASTM E 119.
1. Products: Subject to compliance with requirements, provide one of the following:
    a. FS-One; Hilti Firestop Systems.
    b. SpecSeal Series 100; Specified Technologies, Inc.

2.4 MIXING

A. For those products requiring mixing prior to application, comply with firestopping manufacturer's directions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce firestopping 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 firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings and joints immediately prior to installing firestopping to comply with recommendations of firestopping manufacturer and the following requirements:
1. Remove all foreign materials from surfaces of openings and joint substrates and from penetrating items that could interfere with adhesion of firestopping.
2. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form release agents from concrete.

B. Priming: Prime substrates where recommended by firestopping manufacturer using the 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 firestopping from contacting adjoining surfaces that will remain exposed upon completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestopping

materials. Remove tape as soon as it is possible to do so without disturbing firestopping's seal with substrates.

3.3 INSTALLING THROUGH-PENETRATION FIRESTOPS

A. General: Comply with System Performance Requirements and through-penetration firestop manufacturer's installation instructions and drawings pertaining to products and applications indicated.

B. Install forming/damming materials and other accessories of types required to support fill materials during their application and in the position needed to produce the cross-sectional shapes and depths required to achieve fire ratings of designated through-penetration firestop systems. After installing fill materials, remove combustible forming materials and other accessories no indicated as permanent components of firestop systems.

C. Install fill materials for through-penetration firestop systems by proven techniques to produce the following results:
   1. Completely fill voids and cavities formed by openings, forming materials, accessories and penetrating items.
   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 Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 INSTALLING FIRE-RESISTIVE JOINT SEALANTS

A. General: Comply with System Performance Requirements, with ASTM C 1193, and with the sealant manufacturer's installation instructions and drawings pertaining to products and applications indicated.

B. Install Joint fillers to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability and develop fire-resistant rating required.

C. Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint width and optimum sealant movement capability. Install sealants at the same time joint fillers are installed.

D. Tool nonsag sealants immediately after sealant application and prior to the time skinning or curing begins. Form smooth, uniform beads of configuration indicated or required to produce fire-resistance rating, as well as to eliminate air pockets, and to ensure contact and adhesion of sealant with side of joint. Remove excess sealant from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

END OF SECTION 07 8413

SECTION 07 9200
JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes sealants for the following applications, including those specified by reference to this Section:
   1. Interior joints in vertical surfaces.
   2. Control joints on exposed interior surfaces of exterior walls.
   3. Perimeter joints between interior wall surfaces and frames of interior doors, windows.
   4. Exterior joints.

1.3 PERFORMANCE REQUIREMENTS

A. Provide joint sealants for 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. Install 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.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: 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.

B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.8 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Installer's Warranty: Written warranty, signed by Installer agreeing 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.

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 PRODUCTS AND MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each type in the sealant schedules.

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. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer’s full range for this characteristic.

C. VOC Content of Interior Sealants: Provide sealants and sealant primers for use that comply with the limits for VOC content established by the Authority Having Jurisdication.

2.3 LATEX JOINT SEALANTS

A. Acrylic-Emulsion Sealant: Manufacturer's standard, one part nonsag mildew-resistant, acrylic-emulsion sealant complying with ASTM C 834 formulated to be paintable and recommended for exposed applications on interior and on protected exterior locations involving joint movement of not more than plus or minus 5 percent.
   1. Product: Subject to compliance with requirements, provide products from one of the following:
      a. Bostik Construction Prod. Div.
      b. Pecora Corp.
      c. Sonneborn Bldg. Prod.
      d. Tremco, Inc.
   2. Use for all exposed interior joints except flooring, where movement and where silicone indicated.

2.4 ELASTOMERIC JOINT SEALANTS

A. Multi-Part Nonsag Urethane Sealant for Use NT: Type M, Grade NS, Class 25 and with plus/minus 50 percent movement capability; Uses NT, M, G, A, and, as applicable to joint substrates indicated, O.
   1. Products: Subject to compliance with requirements, provide products from one of the following:
      a. Mameco International, Inc.
      b. Pecora Corp.
      c. Tremco, Inc.
   2. Use for:
      a. All exterior joints except where subject to traffic.
      b. All interior joints at exterior wall.
      c. All interior joints subject to movement, except where subject to traffic.

B. Multi-Part Nonsag Urethane Sealant for Use T: Type M, Grade NS, Class 25; Uses, T, M, G, A and, as applicable to joint substrates indicated, O.
   1. Products: Subject to compliance with requirements, provide products from one of the following:
      a. Bostik Construction Products Div.
      b. Memeco International, Inc.
      c. Pecora Corp.
      d. Products Research & Chemical Corp.
      e. Sika Corp.
      f. Tremco, Inc.
   2. Use for joints subject to traffic.

C. One-Part Mildew-Resistant Silicone Sealant: Type S, Grade NS, Class 25; Uses NT, M, G and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide; intended for sealing interior joints with nonporous substrates and subject to in-service exposure to conditions of high humidity and temperature extremes.
   1. Products: Subject to compliance with requirements, provide products from one of the following:
      a. Dow Corning Corp.
      b. General Electric Co.
      c. Pecora Corp.
      d. Rhone-Poulenc Inc.
      e. Tremco Corp.
      f. Sonneborn Bldg. Prod. Div.

2. Use for plumbing fixtures, toilet accessories and countertops.

2.5 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are non-staining; 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, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
   1. Type O: Open-cell material.

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.

2.6 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 with joint substrates.

C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - <u>EXECUTION</u>

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 from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
a. Concrete.
b. Masonry.
c. 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.
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 of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. 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.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.

E. Install sealants by proven techniques to 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 provided for 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 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 sealants from surfaces adjacent to joint.
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 sealants 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 the original work.

END OF SECTION 07 9200

SECTION 07 9500
EXPANSION CONTROL

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Expansion joint devices for roof surfaces.

1.2 RELATED SECTIONS

A. Section 07 9200 for sealants.

1.3 REFERENCES

A. ANSI/ASTM A276 – Stainless Steel Bars.
B. ANSI/ASTM B221 – Aluminum-Alloy, Extruded Bar, Rod, Wire, Shape, and Tube.
C. ANSI/ASTM B308 - Aluminum-Alloy, Standard Structural Shapes, Rolled or Extruded.

1.4 SUBMITTALS

A. Submit Shop Drawings and Product Data under provisions of Section 01 3300.
B. Indicate joint device profiles, dimensions, locations of the Work, affected adjacent construction, anchorage devices, available colors and finish, and locations of splices.
C. Submit manufacturer's installation instructions under provisions of Section 01 3300.
D. Submit Samples under provisions of Section 01 3300.
E. Submit two samples 6 inches long in size, illustrating profile, dimension, color, and finish selected.

1.4 WARRANTY

A. System Manufacturer: Furnish Owner with written total responsibility guarantee that system will be free of defects, water penetration and chemical damage related to system design, workmanship or material defeciency, consisting of:
    1. Any adhesive or cohesive failures.
    2. Weathering.
    3. Surface crazing.
    4. Abrasion or tear failure resulting from normal traffic use.
B. If material surface shows any of defects listed above, supply labor and material to repair all defective areas and to repaint all damaged line stripes.
C. Guarantee period shall be three years commencing with date of acceptance of Work.
D. Perform any repair under this guarantee at no Cost to Owner.
E. Before construction, provide Architect-Engineer with sample of final guarantee. Guarantee shall be provided by manufacturer.

PART 2 – PRODUCTS

2.1 INTERIOR EXPANSION JOINTS

A. Design Standard:
   1. 2” Exterior wall to roof. Traditional BRB bellows system.
   2. 2” Exterior roof to roof. Traditional BRB bellows system.

B. Acceptable Manufacturers
   1. Balco Inc.
   2. Construction Specialties
   3. MM Systems.
   4. Watson Bowman Inc.

C. Materials
   1. Extruded Aluminum: ANSI/ASTM B221; aluminum alloy, tempered.
   2. Threaded Fasteners: Stainless steel.
   4. Backing Paint: Asphaltic type.
   5. Two component polyurethane sealants.

D. Finish
   1. Clear Anodized.

E. Fabrication
   1. Back paint components in contact with cementitious materials.
   2. Galvanize concealed ferrous metal anchors and fastening devices.
   3. Shop assemble components and package with anchors and fittings.
   4. Provide joint components in single lengths wherever practical. Minimize site splicing.

PART 3 – EXECUTION

3.1 PREPARATION

A. Provide anchoring devices for installation and embedment.
B. Provide templates or rough-in measurements.
C. Verify existing conditions.
D. Verify that joint preparation and affected dimensions are acceptable to manufacturer to allow 50% movement without any permanent damage to joint materials.
E. Clean joints thoroughly in accordance with manufacturer's instructions to remove all laitance, unsound concrete and curing compounds which may interfere with expansion joint materials.
F. Prepare for installation of expansion joint systems in accordance with manufacturer's recommendations.

3.2 INSTALLATION

A. Do all Work in strict accordance with manufacturer's written instructions and specification.
B. Cease material installation under adverse weather conditions, or when temperatures are outside manufacturer's recommended limitations for installation.

C. Align work plumb and level, -flush with adjacent surfaces.
D. Rigidly anchor to substrate to prevent movement or misalignment.
E. Install fire rated systems where required; including safing and retaining bellows.
F. Provide expansion joint in longest continuous lengths possible.

3.3 PROTECTION

A. Protect finished installation.
B. Provide removable coating to protect finish joint surface.
C. Do not permit traffic over unprotected floor joint materials.

END OF SECTION 07 9513

SECTION 08 1113
HOLLOW METAL DOORS AND FRAMES

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 products manufactured in accordance with SDI Recommended Standards:
   1. Doors: Seamless, hollow or composite construction standard steel doors for interior and exterior locations. (Indicated as Hollow Metal "HM" on the Door Schedules.)
   2. Frames: Pressed steel frames for doors, transoms, sidelights, borrowed lights, mullions, interior glazed panels, and other interior and exterior openings of following type: (Indicated as Hollow Metal "HM" on the Door Schedules.):
      a. Welded unit type.
   3. Assemblies: Provide standard steel door and frame assemblies as required for the following:
      a. Labeled and fire rated.
   4. Provide factory primed doors and frames to be field painted.

B. The following sections contain requirements that relate to this Section:
   1. Division 4 Section “Unit Masonry Assemblies” for building in of anchors and grouting of frames in masonry construction.
   2. Division 8 Section “ Flush Wood Doors” for wood doors in hollow metal frames.
   3. Division 8 Section “Door Hardware” for door hardware.
   4. Division 8 Section “Glazing” for glass and glazing.
   5. Division 9 Section "Painting" for painting primed doors and frames.
   6. Division 9 Section “Gypsum Board Assemblies” for grouting frames in gypsum board partitions.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections. Do not proceed with any fabrication until all details are approved.

B. Product data for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, core, label compliance, sound ratings, profiles, and finishes.

C. Shop drawings showing fabrication and installation of standard steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of door and frame hardware and

reinforcements, and details of joints and connections. Show anchorage and accessory items.

1. Provide schedule of doors and frames using same reference numbers for details and openings as those on contract drawings.
2. Indicate coordinate of glazing frames and stops with glass and glazing requirements.

D. Label Construction Certification: For door assemblies required to be fire-rated and exceeding limitations of labeled assemblies, submit manufacturer's certification that each door and frame assembly has been constructed to conform to design, materials and construction equivalent to requirements for labeled construction.

1.4 QUALITY ASSURANCE

A. Provide doors and frames complying with Steel Door Institute "Recommended Specifications Standard Steel Doors and Frames" ANSI/SDI-100 and as herein specified.

B. Fire-Rated Door Assemblies: Units that comply with NFPA 80, are identical to door and frame assemblies whose fire resistance characteristics have been determined per ASTM E 152 and which are labeled and listed by UL, Factory Mutual, Warnock Hersey, or other testing and inspecting organization acceptable to authorities having jurisdiction.

C. Hollow metal supplier will be a qualified direct distributor of products to be furnished. Supplier must have facilities within 100 miles of the project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Inspect doors and frames upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to Architect; otherwise, remove and replace damaged items as directed.

C. Store doors and frames at building site under cover. Place units on minimum 4-inches high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4-inches spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide standard steel doors and frames by one of the following:

1. Standard Steel Doors and Frames:
   a. Ceco Door Co.
   b. Curries Co.
   c. Fenestra
   d. Pioneer

e. Republic
f. Steelcraft Division

2.2 MATERIALS

A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, complying with ASTM A 569 and ASTM A 568.
B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with ASTM A 366 and ASTM A 568.
C. Supports and Anchors: Fabricate of not less than 18-gage sheet steel; galvanized where used with galvanized frames.
D. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where items are to be built into exterior walls, hot-dip galvanize in compliance with ASTM A 153, Class C or D as applicable.
E. Shop Applied Paint: Apply after fabrication.
    1. Primer: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as a base for specified finish paints complying with ANSI A224.1, "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames."

2.3 DOORS

A. Provide metal doors of SDI grades and models specified below or as indicated on drawings or schedules:
    1. Interior Doors: ANSI/SDI-100, Grade II, heavy-duty, Level 3 or 4, minimum 18-gage cold-rolled sheet steel faces.
    2. Exterior Doors: Grade II, Heavy-Duty, Level 3 or 4, seamless design, minimum 0.0478 inch (1.2 mm) thick cold rolled galvanized steel sheet faces. (18 gage).
    3. Doors shall have beveled (1/8" in 2") hinge and lock edge with edge seam welded and ground smooth. Furnish steel top and bottom caps. Maximum undercut of door will be 5/8" or less, unless noted otherwise.

2.4 FRAMES

A. Provide metal frames for doors, transoms, sidelights, borrowed lights, and other openings, of types and styles as shown on drawings and schedules. Conceal fastenings, unless otherwise indicated. Fabricate frames of minimum 16-gage cold-rolled steel.
    1. Fabricate frames with mitered, coped, or welded corners. KD frames will not be permitted.
    2. Form exterior frames from 14-gage hot dipped A60 galvanized steel.
B. Door Silencers: Except on weatherstripped frames, drill stops to receive 3 silencers on strike jambs of single-door frames and 2 silencers on heads of double-door frames.
C. Plaster Guards: Provide minimum 26-gage steel plaster guards or mortar boxes at back of hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.
D. Provide double temporary spreader bars to be removed before setting frames.

E. Grout: Grout complying with ASTM C476 with 3,000 psi compressive strength in 28 days. Grout all door frames solid. Coordinate with division 4, Masonry and Division 9, Gypsum Board Assemblies.

2.5 FABRICATION

A. Fabricate steel door and frame units to be rigid, neat in appearance and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at project site. Comply with ANSI/SDI-100 requirements.
   1. Internal Construction: Manufacturer's standard rigid, polyurethane, in accordance with SDI standards, and ASTM C591.
   2. Clearances: Not more than 1/8 inch at jambs and heads except between non-fire-rated pairs of doors not more than 1/4 inch. Not more than 3/4 inch at bottom.

B. Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from only cold-rolled steel.

C. Tolerances: Comply with SDI 117 "Manufacturing Tolerances Standard Steel Doors and Frames."

D. Fabricate frames, concealed stiffeners, reinforcement, edge channels, louvers and moldings from either cold-rolled or hot-rolled steel.

E. Fabricate exterior doors, panels, and frames from galvanized sheet steel in accordance with SDI-112. Close top and bottom edges of exterior doors as integral part of door construction or by addition of minimum 16-gage inverted steel channels.

F. Thermal-Rated (Insulating) Assemblies: At exterior doors and elsewhere as shown or scheduled, provide hollow metal units which have been fabricated as thermal insulating assemblies and tested in accordance with ASTM C 236 or C 976. Provide assemblies with U-value rating of 0.24 Btu or better.

G. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

H. Finish Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware in accordance with final Door Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 Series Specifications for door and frame preparation for hardware.
   1. For concealed hardware, provide space, cutouts, reinforcing and provisions for fastening in doors and frames, as applicable.

I. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware to be done at project site.

J. Locate hardware as indicated on final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware on Standard Steel Doors and Frames," published by Door and Hardware Institute.

K. Shop Painting: Clean, treat, and paint exposed surfaces of steel door and frame units, including galvanized surfaces.

1. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.
2. Apply shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive finish paint.

L. Glazing Stops: Minimum 20 gage steel.
1. Provide non-removable stops on outside of exterior doors and on secure side of interior doors for glass, louvers, and other panels in doors.
2. Provide screw applied removable glazing beads on inside of glass, louvers, and other panels in doors.

M. Mechanically fasten labels to rated frames.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install standard steel doors, frames, and accessories in accordance with final shop drawings, manufacturer's data, and as herein specified.

B. Placing Frames: Comply with provisions of SDI-105 "Recommended Erection Instructions For Steel Frames," unless otherwise indicated.
1. Except for frames located at existing concrete, masonry or drywall installations, place frames prior to construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
2. In masonry construction, locate 3 wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry Tee anchors. Provide four (4) wall anchors per jamb for frame over 7'-2" high.
3. Install fire-rated frames in accordance with NFPA Standard No. 80.
4. In metal stud partitions, install at least 3 wall anchors per jamb at hinge and strike levels. In closed steel stud partitions, attach wall anchors to studs with screws.
5. At existing in-place drywall partitions install knock down slip-on drywall frames.
6. Grout all door frames solid.

C. Door Installation: Fit hollow metal doors accurately in frames, within clearances specified in ANSI/SDI-100.
1. Install fire-rated doors with clearances as specified in NFPA Standard No. 80.

3.2 ADJUST AND CLEAN

A. Prime Coat Touch-up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

B. Protection Removal: Immediately prior to final inspection, remove protective plastic wrappings from prefinished doors.

C. Final Adjustments: Check and readjust operating hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.

END OF SECTION 08 1113

SECTION 08 1416
FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Solid-core doors with Hardwood veneer & edges for transparent finish.
B. Related Sections include the following:
   1. Division 8 Section "Glazing" for glass view panels in flush wood doors.
   2. Division 8 Section “Hollow Metal Doors and Frames”.
   3. Division 8 Section “Fire Rated Aluminum Entrances and Storefront”.
   4. Division 8 Section “Finish Hardware”.

1.3 SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction, trim for openings, and louvers.
   1. Include factory-finishing specifications.
B. 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.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.
B. Quality Standard: Comply with the following standard:
   1. AWI Quality Standard: AWI's "Architectural Woodwork Quality Standards" for grade of door, core, construction, finish, and other requirements.
C. Product Certification: Require door manufacturer to certify that flush wood doors comply with specified requirements including those of referenced door standard.
D. Fire-Rated Wood Doors: Provide wood doors that comply with NFPA 80.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration. Comply with requirements of referenced standard and manufacturer's written instructions.
   1. Individually package doors in cardboard cartons and wrap bundles of doors in plastic sheeting.
B. Mark each door with individual opening numbers used on Shop Drawings. Use removable tags or concealed markings.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during the remainder of the construction period to comply with requirements of the referenced quality standard for Project's geographical location.

1.7 WARRANTY

A. General Warranty: Door manufacturer's warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Door Manufacturer's Warranty: Submit written agreement on door manufacturer's standard form, signed by manufacturer and Installer agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section or that show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span, or do not comply with tolerances in referenced quality standard.
   1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
   2. Warranty shall be in effect during the following period of time after the date of Substantial Completion:
      a. Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flush Wood Doors:
      a. Algoma Hardwoods Inc.
      b. Eggers Industries; Architectural Door Division.
      c. Graham Manufacturing Corp.
      d. Mohawk Flush Doors, Inc.
      e. Weyerhaeuser Co.
      f. Oshkosh Door Company

2.2 DOOR CONSTRUCTION, GENERAL

A. Doors for stained finish: Comply with the following requirements:
   1. Grade: Premium.
   2. Faces: Red Oak, plain sliced, book matched.
   3. Factory Finish: AWI System TR-4 conversion varnish
   4. Staining: Match Architect’s sample.
   5. Effect: Closed grain (filled) finish.
   6. Sheen: Satin.
   7. Stiles: Same specie as face.

2.3 SOLID-CORE DOORS

A. Interior Veneer-Faced Doors: Comply with the following requirements:
   1. Core: Particle board.
   2. Construction: Five plies (PC-5).

2.4 FIRE-RATED SOLID CORE DOORS

A. Construction: Manufacturer’s standard mineral core construction as required to provide fire-resistance rating indicated.

B. Edge Construction: Provide manufacturer’s standard laminated edge construction for improved screw-holding capability and split resistance as compared to edges composed of a single layer of treated lumber.

C. Labels shall be mechanically attached. Adhered labels are not acceptable.

2.5 LIGHT FRAMES

A. Metal Frames for light openings in fire-rated and non-fire rated doors.

2.6 FABRICATION

A. Fabricate flush wood doors in sizes indicated for Project site fitting.
B. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:
   1. Comply with clearance requirements of referenced quality standard for fitting
C. 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 measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
D. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.
   1. Light Openings: Trim openings with moldings of material and profile indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine 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 plumb jambs and level heads.
   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 8 Section “Door Hardware.”
B. Manufacturer’s Written Instructions: Install wood doors to comply with manufacturer’s written instructions, referenced quality standard, and as indicated.
C. Job-Fit 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. Machine doors for hardware. Seal cut surfaces 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. Where threshold is shown or scheduled, provide ¼ inch from bottom of door to top of threshold.
   2. Bevel doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.

3.3 ADJUSTING AND PROTECTING

A. Operation: Re-hang or replace doors that do not swing or operate freely.
B. Finished Doors: Refinish or replace doors damaged during construction.
C. Protect doors as recommended by door manufacturer to ensure that wood doors are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 08 1416

SECTION 08 3113
ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Rated and non-rated access doors and frames for gypsum board walls and ceilings.

1.3 RELATED SECTIONS

A. Division 8 Section "Door Hardware".
B. Division 9 Section “Gypsum Board”.

1.4 SUBMITTALS

A. Product Data: For each type of access door and frame indicated. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
B. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other work.
C. Access Door and Frame Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain access door(s) and frame(s) through one source from a single manufacturer.
B. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units.

1.6 COORDINATION

A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, or other concealed work.

PART 2 - PRODUCTS

2.1 STEEL MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
B. Steel Sheet: Uncoated cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
C. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and

designating finishes.

1. Surface Preparation for Steel Sheet: 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 SSPC-SP 8, "Pickling."
2. Factory-Primed Finish: Apply shop primer immediately after cleaning and pretreating.

2.2 ACCESS DOORS AND FRAMES FOR GYPSUM BOARD ASSEMBLIES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Babcock-Davis; A Cierra Products Co.
   2. Dur-Red Products.
   3. Karp Associates, Inc.
   4. Larsen's Manufacturing Company.
   5. Milcor Inc.
   6. Nystrom, Inc.
   7. Williams Bros. Corporation of America.

B. Architectural Grade Flush Access Doors: Fabricated from steel sheet.
   1. Locations: Gypsum Board surfaces.
   2. Door: 16 ga. cold rolled steel.
   3. Frame: 16 ga. cold rolled steel. Frame to be provided with pre-formed mounting holes 3/16 “ diameter at 4” spacing. Inner frame included to allow latching.
   4. Hinge: Concealed spring hinges open to 175° for complete access without allowing the door to impact the wall. Quantity varies per door panel size. Extracting pin from hinge leaf attached to panel permits panel removal.
   5. Latch: Screwdriver operated cam latch. Quantity varies per door panel size.
   6. Finish: Powder coat - White.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces 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, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
   1. Exposed Flanges: Nominal 3/4 inches wide around perimeter of frame.
   2. Provide mounting holes in frames for attachment of units to metal framing.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
   1. For cylinder lock, furnish two keys per lock and key all locks per owner requirement.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.
B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
C. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING AND CLEANING

A. Adjust doors and hardware after installation for proper operation.
B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 3113

SECTION 08 3313
COILING COUNTER DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Attention is directed to Division 0, Bidding and Contract Requirements, and to Division 1, General Requirements, which are hereby made a part of this Section.

1.2 DESCRIPTION OF WORK

A. Extent of coiling counter doors is shown on drawings.
B. Types of coiling counter doors required include the following:
   1. Fire rated galvanized steel, manually operated.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who is an authorized representative of the metal counter door manufacturer for both installation and maintenance of units required for this project.
B. Furnish each metal counter door as a complete unit produced by one manufacturer, including shutter curtains, guides, counterbalance mechanism, hardware, accessories, mounting and installing components.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each type and size metal counter door required. Include details of construction relative to materials, dimensions of individual components, profiles and finishes. Provide roughing-in diagrams, operating instructions and maintenance information.
B. Shop Drawings: Submit shop drawings for entire assembly showing details of metal counter door and its support, guides and their support and all related accessories.
C. Samples for Verification Purposes: Submit pairs of samples of each type and color of metal finish on 12 inch long sections of extrusions or formed shapes and on 6 inch square sheets. Where color or texture variations are anticipated, include 2 or more units in each set of samples indicating extreme limits of variations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
   1. Atlas Door Corp., Div. of Clopay Building Products Co.
   2. The Cookson Co.
   3. Cornell Iron Works, Inc.
   4. Mahon Door Corp.
   5. Overhead Door Company
   6. Raynor

2.2 COUNTER DOOR CURTAIN AND CONSTRUCTION

A. Door Curtain: Fabricate door curtain of interlocking slats of continuous length for width of door without splices. Provide slats of material thickness recommended by door manufacturer for size and type of door required, and as follows:
   1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold rolled structural steel (SS) sheet; complying with ASTM A 653, G90 coating designation, phosphate treated before fabrication.
   2. Furnish manufacturer's standard flat profile slats in flush appearance.

B. Endlocks: Manufacturer's standard locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement, unless otherwise required for fire rating.

C. Bottom Bar: Manufacturer's standard continuous channel or tubular shape, to suit type of curtain slats.

D. Curtain Jamb Guides: Fabricate curtain jamb guides of angles, or channels and angles or material and finish to match curtain slats, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Provide continuous integral wear strips to prevent metal contact and minimize noise of travel and removable stops on guides to prevent overtravel of curtain.

2.3 ACCESSORIES

A. Push/Pull Handles: Provide manufacturer's standard heavy duty lifting handles on inside of door.

B. Integral Frame, Hood and Fascia for Counter Doors: Provide welded assemblies of the following sheet metal:
   1. Fabricate from minimum 0.064 inch thick, hot dip galvanized steel sheet with G90 zing coating, complying with ASTM A 653.

C. Smoke Seals: Provide UL listed and tested smoke seal perimeter gaskets.

D. Provide automatic closing device that is inoperative during normal door operations, with oscillating governor unit complying with requirements of NFPA 80 and with an easily tested and reset release mechanism, and designed to be activated by the following:
   1. Counter Doors: Replaceable fusible links with temperature rise and melting point of 165 deg F (74 deg C); interconnected and mounted on both sides of door opening; or by manufacturer's standard UL labeled smoke detector, building fire alarm and detection system and door holder release devices.

2.4 COUNTERBALANCING MECHANISM

A. Counterbalance counter doors by means of adjustable steel helical torsion spring, mounted around a steel shaft and contained in a spring barrel connected to door curtain with required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of hot-formed structural quality carbon steel welded or seamless pipe, of sufficient diameter and wall thickness to support roll-up curtain without distortion of slats and limit barrel deflection to not more than 0.03 inch per foot of span under full load.
   1. Provide spring balance of 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. Provide cast steel barrel plugs to secure ends of springs to barrel and shaft.

2. Fabricate torsion rod for counterbalance shaft of cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

C. Brackets: Provide mounting brackets of manufacturer's standard design, either cast iron of cold-rolled steel plate with bell mouth guide groove for curtain.

2.5 FINISHES, GENERAL

A. Comply with NAAMM "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within ½ of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components as acceptable if they are within the range of approved samples and they are assembled or installed to minimize contrast.

2.6 STEEL AND GALVANIZED STEEL FINISHES

A. Factory Primer for Field Finish: Manufacturer's standard primer, compatible with field applied finish according to coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

2.7 MANUAL OPERATION

A. Design counterbalance mechanism so that required lift of pull for counter door operation does not exceed 25 pounds. Adjust operating mechanism so that curtain can be easily stopped at any point in its travel and to remain in position until movement is reactivated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which metal counter door units are to be installed. Notify Architect in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

3.2 INSTALLATION

A. Install counter doors and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers and equipment supports in accordance with final shop drawings, manufacturer's instructions and as specified herein.

B. Upon completion of installation including work by other trades, lubricate, test and adjust counter doors to operate easily, free from warp, twist of distortion and fitting tight for entire perimeter.

END OF SECTION 08 3313

SECTION 08 3323
OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specifications Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Overhead coiling doors, operating hardware, electric operation.
B. Wiring from electric circuit disconnect to door operator to control station.

1.2 REFERENCES

A. ANSI/ASTM A526 - Steel Sheet, Zinc-coated (Galvanized) by the Hot-dip Process, Commercial Quality.
B. ANSI/ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.
C. ANSI/UL 325 - Door, Drapery, Gate, Louver, and Window Operators and Systems.
D. ASTM A480 - Flat Rolled Stainless and Heat Resisting Steel Plate, Sheet and Strip.
E. ASTM A525 - General Requirements for Steel Sheet, Zinc-coated (Galvanized) by the Hot-Dip Process.
F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
G. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.
H. NEMA MG1 - Motors and Generators.
I. ULI - Underwriters' Laboratories Inc.

1.3 SYSTEM DESCRIPTION

A. Overhead doors shall be electric motor operated unit with manual override in case of power failure.
B. Surface mounted.

1.4 DESIGN REQUIREMENTS

A. Design exterior door assembly to withstand wind/suction load of 20 psf, without undue deflection or damage to door shutter or assembly components.
B. Exterior Door Insulation Value: R of 6.33.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 3300.
B. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
C. Product Data: Provide general construction, component connections and details, and electrical equipment.
D. Manufacturer's Installation Instructions: Indicate installation sequence and procedures, adjustment, and alignment procedures.

1.6 MAINTENANCE DATA

A. Submit under provisions of Section 01 7300.
B. Maintenance Data: Indicate lubrication requirements and frequency, and periodic adjustments required.

1.7 REGULATORY REQUIREMENTS

A. Electrical Components: UL listed.
B. Fire Rated Shutters: UL Labeled.

1.8 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on Shop Drawings.

1.9 COORDINATION

A. Coordinate work with related trades.
B. Coordinate the work with installation of electric power, locations and size of conduit.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS ARE:

A. The Cookson Company.
B. Cornell Iron Works.
C. Atlas Roll-Lite Door Corp.
D. Overhead Door Corp.
E. McKeon.

2.2 MATERIALS

A. Curtain: conforming to the following:
    1. Slats: Interlocking, minimum 20 gage of ANSI/ASTM A526 steel, galvanized to minimum 1.25 oz/sq ft coating in accordance with ASTM A525; single thickness slat sandwich slat construction with insulated core of urethane type insulation.
    2. Nominal Slat Size: 3 inches wide x required length.
    3. Slat Ends: Alternate slats. Each slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
    4. Curtain Bottom: Fitted with galvanized steel angles to provide reinforcement and positive contact with floor in closed position.
B. Guides: Galvanized structural steel angles, minimum 3/16” thick.
C. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to assure smooth operation of curtain from any position; with adjustable spring tension. Design for minimum 50,000 cycles.
D. Hood Enclosure and Fascia: 24 gage galvanized steel; internally reinforced to maintain rigidity and shape.
E. Hardware:
    1. Locking: Cylinder type.
    2. Handle: Inside side mounted, adjustable keeper, spring activated latch bar with feature to keep in locked position; interior handle.

3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure.

2.3 ELECTRIC OPERATOR

A. Electric Operator:
   1. Description: ANSI/UL 325, side mounted.
   2. Motor Enclosure: NEMA MG1 Type 1; open drip proof.
   3. Motor Rating: ¾ hp; continuous duty.
   4. Motor Voltage: 120 volt, single phase, 60 Hz.
   5. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
   6. Controller Enclosure: NEMA 250 Type 1
   7. Door Shutter Speed: 12 inches per second.
   8. Brake: Adjustable friction clutch type, activated by motor controller.

B. Control Station: Standard three button (open-close-stop) control for each operator; 24 volt circuit; surface mounted.

C. Safety Edge: Located at door shutter bottom, full width, electro-mechanical sensitized type, wired to stop reverse door shutter upon striking object, hollow neoprene rubber covered weather seal.

2.4 FINISHES

A. Curtain Slats: Galvanized steel (Factory Painted) Color as selected by architect.

B. Steel Guides and Hood Enclosure: Prime paint Prepare for field paint finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Field Verify openings.

B. Verify that opening sizes, tolerances and conditions are acceptable.

3.2 INSTALLATION

A. Install door unit assembly in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely brace components suspended from structure. Secure guides to structural members only.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service with electrical trades. Complete wiring from disconnect to unit components and to door shutter operator.

F. Coordinate interlock of fire shutters with fire alarm trades.

G. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07 9200.

H. Install perimeter trim and closures.

3.3 ERECTION TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.
B. Maximum Variation From Plumb: 1/16 inch.
C. Maximum Variation From Level: 1/16 inch.
D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.4 ADJUSTING

A. Adjust door shutter, hardware and operating assemblies.
B. Test fire rated assembly as required for the Authority Having Jurisdiction.

3.5 CLEANING

A. Clean door shutter and components.
B. Remove labels and visible markings.

END OF SECTION 08 3323

SECTION 08 3613
SECTIONAL OVERHEAD DOORS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Electric overhead sectional door.
B. Glass fiber sheet insulated panels of flush design.
C. Operating hardware and supports.

1.2 REFERENCES

A. ANSI A216.1 – Section Overhead Type Door (NAGDM 102).
B. ANSI A135.4 – Basic Hardboard.
C. ANSI/ASTM A446 – Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process, Structural (Physical) Quality.
D. ANSI/ASTM A526 – Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process, Commercial Quality.
E. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate.
F. ASTM B221 – Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
G. NEMA – National Electrical Manufacturer's Association.

1.3 SYSTEM DESCRIPTION

A. Panels: Flush glass fiber sheet nominal 2 inches thick.
B. Standard lift track and hardware.
C. Electric operation on 120 volt, single phase, 60 Hz service to ½ HP motor manually operable in case of power failure, min. transit time of 12 inches per second.

1.4 QUALITY ASSURANCE

A. Manufacturer: Company specializing in overhead door construction with three years minimum experience.
B. Applicator: Company specializing in installing overhead doors with three years documented experience and approved by manufacturer.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable code for motor and motor control requirements.

1.6 SUBMITTALS

A. Submit Shop Drawings and Product Data under provisions of Section 01300.
B. Indicate opening dimensions and tolerances, component construction, connections and details, anchorage methods and spacing, hardware and locations, and installation details.
C. Submit manufacturer's installation instructions under provisions of Section 01300.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 01700.

B. Include data for motor shaft and gearing, lubrication frequency, control adjustments, and spare part sources.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Raynor

B. Overhead Door

C. Clopay

D. Wayne-Dalton

E. Atlas

F. Substitutions: Under provisions of Sections 01600 and 01600A.

2.2 MATERIALS

A. Glass Fiber Sheet: Opaque, glass fibers bonded in polyester resin with polyvinylchloride film coating, ¼ inch thick, color as selected by Architect-Engineer.

B. Insulation: Fibrous glass batt, unfaced; Rigid polystyrene polyurethane; same thickness as core framing members bonded to facing.

C. Weatherstripping: Resilient rubber strip.

2.3 COMPONENTS

A. Panels: Panelled aluminum construction with extruded aluminum stiles and rails; 2 inch thick infill panels of glass fiber sheet; stile and rail joints welded; internally reinforced with cast aluminum brackets; rabbeted weather joints at meeting rails.

B. Track: 11 gage thick by inch wide rolled steel track, continuous, vertical mounted; galvanized steel mounting brackets, ¼ inch thick.

C. Hinge and Roller Assemblies: Heavy duty hinges and adjustable roller holders of galvanized steel; floating hardened steel ball bearing rollers, located at top and bottom of each panel at meeting joint.

D. Lock: Inside side mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position; interior and exterior handle; lock master keyed with Section 08712.

E. Door Panel Weather-stripping: At bottom of door panel, full width; double contact resilient.

F. Jamb Weather-stripping: Roll formed aluminum fitted full height of jamb with integral resilient weather-stripping in moderate contact with door panels.

G. Lift Mechanism: Torsion spring on cross head shaft, with braided steel lift cables.

H. Electric Operator: NEMA Type 1 UL approved motor; center mounted draw bar assembly; adjustable safety friction clutch; brake system actuated by independent voltage solenoid controlled by motor starter;

enclosed gear driven limit switch; enclosed magnetic cross line reversing starter, mounting brackets and hardware.

I. Control Station: Standard three button (open-close-stop) momentary hold type control for each electric operator; 24 volt circuit; surface mounted.

J. Radio Control

K. Safety Edge: At bottom of door panel, full width; electromechanical sensitized type, wired to reverse door upon striking object; hollow rubber covered to provide weather-strip seal.

L. Borrowed Lite Panels: provide as indicated on drawings

2.4 FINISHES

A. Glass Fiber Sheet: off-white color as selected by architect from manufacturer's standard range.

PART 3 – EXECUTION

3.1 INSPECTION

A. Verify that wall openings are ready to receive work and opening dimensions and tolerances are within limits.

B. Beginning of installation means acceptance of existing surfaces.

3.2 PREPARATION

A. Prepare opening to permit correct installation of door unit and air and vapor barrier seal.

3.3 INSTALLATION

A. Install door unit assembly in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely brace door tracks suspended from structure. Secure tracks to structural members only.

D. Fit and align door assembly including hardware, level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service. Complete wiring from disconnect to unit components.

F. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07900.

G. Install perimeter trim and closures.

3.4 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Variation from Plumb: 1/8 inch maximum.

C. Variation from Level: 1/8 inch maximum.

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch from 10 ft. straight edge.

3.5 ADJUSTING AND CLEANING

A. Adjust door assembly.

B. Clean doors.
C. Remove labels and visible markings.

END OF SECTION 08 3613

SECTION 08 4113
ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section Includes:
   1. Aluminum-Framed Entrances.

B. Related Sections: Refer to:
   1. Division 08 Section “Glazing”.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
   1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
   2. Dimensional tolerances of building frame and other adjacent construction.
   3. Failure includes the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferring to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
      d. Noise or vibration created by wind and by thermal and structural movements.
      e. Loosening or weakening of fasteners, attachments, and other components.

B. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   1. Design Factors:
      a. Wind Speed: 90 mph.
      b. Exposure B.
      c. Building height: 30 ft.
      d. Importance Factor: Category III.

C. Deflection of Framing Members:
   1. Deflection Normal to Wall Plane: Edge of glass in a direction perpendicular to glass plane shall not exceed the following, whichever is less:

a. L/175 of the glass edge length for each individual glazing lite, per Michigan Building Code recommendations for framing members supporting glass.
b. 1/175 of clear span for spans up to 13 feet 6 inches and 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches, per AAMA TIR-A11 recommendations
c. 3/4 inch edge deflection of individual glazing lites.

2. Deflection Parallel to Glazing Plane: Limited to the following, whichever is smaller:
a. L/360 of clear span or 1/8 inch.
b. An amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components directly below them to less than 1/8 inch and clearance between members and operable units directly below them to less than 1/16 inch.

D. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
1. When tested at 150 percent percent of positive and negative wind-load design pressures, systems, including anchorage, shall not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent percent of span.
2. Test Durations: 10 seconds.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: For aluminum-framed systems. 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.
C. Samples: For each type of exposed finish required.
D. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
E. Product test reports.
F. Maintenance data.
G. Warranties: Sample of special warranties.

1.5 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. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of

manufacturer's standard units in systems similar to those indicated for this Project.

D. Product Options: Information on Drawings and in Specifications establishes requirements for systems' 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 preconstruction testing, field testing, and in-service performance.

E. 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.

F. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.

1.6 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. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Design Standard:

1. Kawneer Trifab VG451T System, Front Glazed profiles
2. Kawneer Trifab VG451 System, Center Glazed profiles.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CMI Architectural.
2. EFCO Corporation.
3. Kawneer North America; an Alcoa company.
4. Tubelite.
5. United States Aluminum.
6. Vistawall Architectural Products; The Vistawall Group; a Bluescope Steel company.
7. 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: (if any) AWS A5.10/A5.10M.

B. Steel Reinforcement: (If any) 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.
2. Cold-Rolled Sheet and Strip: ASTM A 1008.
3. Hot-Rolled Sheet and Strip: ASTM A 1011.

2.3 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Profiles and Glazing Plane:
   a. Storefront Framing: As detailed.
2. Construction: Thermally broken.
3. Glazing System: Retained mechanically with gaskets on four sides.

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.
3. Where exposed fasteners are shown on approved Shop Drawings, use exposed fasteners with countersunk Phillips screw heads, fabricated from stainless steel.

D. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.

2.4 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

2.5 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.

2.6 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. Framing Members, General: 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. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing from interior.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 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 non-movement 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 Division 07 Section "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 Division 08 Section "Glazing."

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections.

B. Testing Services: Testing and inspecting of representative areas to determine compliance of installed systems with specified requirements shall take place as follows. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.

1. 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.

C. Repair or remove work if test results and inspections indicate that it does not 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.

E. Aluminum-framed assemblies will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 08 4113

SECTION 08 7100
DOOR HARDWARE

PART 1 - GENERAL

1.1 Refer to "General and Special Conditions", and "Instructions to Bidders", Division 1 of Specifications. Requirements of these Sections and the project drawings shall govern work in this section.

1.2 WORK INCLUDED:

A. Furnish all items of Finish Hardware specified, scheduled, shown or required herein except those items specifically excluded from this section of the specification.

B. Related work:

1. Division 00 00 00 – Procurement and Contracting Requirements
2. Division 01 00 00 – General Requirements
3. Division 06 00 00 – Wood, Plastics, and Composites
4. Division 08 00 00 – Openings
5. Division 10 00 00 – Specialties
6. Division 11 00 00 – Equipment
7. Division 26 00 00 – Electrical
8. Division 27 00 00 – Communications
9. Division 28 00 00 – Electronic Safety and Security

C. Specific Omissions: Hardware for the following is specified or indicated elsewhere, unless specifically listed in the hardware sets:

1. Cabinet Hardware.
2. Signs, except as noted.
3. Folding partitions, except cylinders where detailed.
4. Sliding aluminum doors
5. Chain link and wire mesh doors and gates
6. Access doors and panels
7. Overhead and Coiling doors

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:

1. Furnish finish hardware to comply with the requirements of laws, codes, ordinances, and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications.
2. Furnish finish hardware to comply with the requirements of the regulations for public building accommodations for physically handicapped persons of the

governmental authority having jurisdiction and to comply with Americans with Disabilities Act.

3. Provide hardware for fire-rated openings in compliance with NFPA 80 and state and local building code requirements. Provide only hardware that has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame labels.

B. Hardware Supplier:

1. Shall be an established firm dealing in contract builders' hardware. He must have adequate inventory, qualified personnel on staff and be located within 100 miles of the project. The distributor must be a factory-authorized dealer for all materials required. The supplier shall be or have in employment an Architectural Hardware Consultant (AHC).

C. Electrified Door Hardware Supplier:

1. Shall be an experienced door hardware supplier who has completed projects with electrified door hardware 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, and who is acceptable to manufacturer of primary materials.
2. Shall prepare data for electrified door hardware, including shop drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this project.
3. Shall have experience in providing consulting services for electrified door hardware installations.

D. Pre-installation Meeting:

1. Before hardware installation, General Contractor/Construction Manager will request a hardware installation meeting be conducted on the installation of hardware; specifically that of locksets, closers, exit devices, overhead stops and coordinators. Manufacturer's representatives of the above products, in conjunction with the hardware supplier for the project, shall conduct the meeting. Meeting to be held at job site and attended by installers of hardware for aluminum, hollow metal and wood doors. Meeting to address proper coordination and installation of hardware, per finish hardware schedule for this specific project, by using installation manuals, hardware schedule, templates, physical product samples and installation videos.
2. When any electrical or pneumatic hardware is specified this meeting shall also include the following trades/installers: Electrical, Security, Alarm systems and Architect.
3. Convene one week or more prior to commencing work of this Section.
4. The Hardware Supplier shall include the cost of this meeting in his proposal.

E. Manufacturer:

1. Obtain each type of hardware (latch and locksets, hinges, closers, etc.) from a single manufacturer, although several may be indicated as offering products complying with requirements.
2. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated.

1.4 SUBMITTALS:

A. Hardware Schedule

1. Submit number of Hardware Schedules as directed in Division 1.
2. Follow guidelines established in Door & Hardware Institute Handbook (DHI) Sequence and Format for the Hardware Schedule unless noted otherwise.
3. Schedule will include the following:
   a. Door Index including opening numbers and the assigned Finish Hardware set.
   b. Preface sheet listing category only and manufacturer's names of items being furnished as follows:

CATEGORY	SPECIFIED	SCHEDULED
Hinges	Manufacturer A	Manufacturer B
Lock sets	Manufacturer X	Manufacturer X
Kick Plates	Open	Manufacturer Z

   c. Hardware Locations: Refer to Article 3.1 B.2 Locations.
   d. Opening Description: Single or pair, number, room locations, hand, active leaf, degree of swing, size, door material, frame material, and UL listing.
   e. Hardware Description: Quantity, category, product number, fasteners, and finish.
   f. Headings that refer to the specified Hardware Set Numbers.
   g. Scheduling Sequence shown in Hardware Sets.
   h. Product data of each hardware item, and shop drawings where required, for special conditions and specialty hardware.
   i. Electrified Hardware system operation description.
   j. "Vertical" scheduling format only. "Horizontal" schedules will be returned "Not Approved."
   k. Typed Copy.
   l. Double-Spacing.
   m. 8-1/2 x 11 inch sheets
   n. U.S. Standard Finish symbols or BHMA Finish symbols.

B. Product Data:

1. Submit, in booklet form Manufacturers Catalog cut sheets of scheduled hardware.
2. Submit product data with hardware schedule.

C. Samples:

1. Prior to submittal of the final hardware schedule and prior to final ordering of finish hardware, submit one sample, if required, of each type of exposed hardware unit, finished as required and tagged with full description for coordination with schedule.
2. Samples will be returned to the supplier. Units, which are acceptable and remain undamaged through submittal, review and field comparison procedures may, after final check of operation, be used in the work, within limitations of keying coordination requirements.

D. Key Schedule:

1. Submit detailed schedule indicating clearly how the Owner's final keying instructions have been followed.
2. Submit as a separate schedule.

E. Electrified Hardware Drawings:

1. Submit elevation drawings showing relationship of all electrical hardware components to door and frame. Indicate number and gage of wires required.
   a. Include wiring drawing showing point to point wire hook up for all components.
   b. Include system operations descriptions for each type of opening; describe each possible condition.

F. Submit to General Contractor/Construction Manager, the factory order acknowledgement numbers for the various hardware items to be used on the project. The factory order acknowledgement numbers shall help to facilitate and expedite any service that may be required on a particular hardware item. General Contractor/Construction Manager shall keep these order acknowledgement numbers on file in the construction trailer.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Label each item of hardware with the appropriate door number and Hardware Schedule heading number, and deliver to the installer so designated by the contractor.

1.6 EXISTING CONDITIONS:

A. Where existing doors, frames and/or hardware are to remain, conditions, preparations and functions shall be field verified to confirm compatibility with specified hardware. Where any incompatibility is discovered, notify the contractor or construction manager immediately and provide a suggested solution based on industry standard business practices.

1.7 WARRANTIES:

A. Refer to Division 1 for warranty requirements.

B. Special Warranty Periods:

1. Closers shall carry manufacturer's 30-year warranty against manufacturing defects and workmanship.
2. Locksets shall carry manufacturer's 3-year warranty against manufacturing defects and workmanship.
3. Exit Devices shall carry manufacturer's 3-year warranty against manufacturing defects and workmanship.
4. Continuous gear hinges shall carry manufacturer's lifetime warranty to be free from defects in material and workmanship.
5. Balance of items shall carry a manufacturer's 1-year warranty against manufacturing defects and workmanship.

C. During the warranty period, replace defective work, including labor, materials and other costs incidental to the work.

PART 2 - PRODUCT

2.1 Furnish each category with the products of only one manufacturer unless specified otherwise; this requirement is mandatory whether various manufacturers are listed or not.

2.2 Provide the products of manufacturer designated or if more than one manufacturer is listed, the comparable product of one of the other manufacturers listed. Where only one manufacturer or product is listed, it is understood that this is the owner's Building Standard and "no substitution" is allowed.

A. Hinges:

1. Furnish hinges of class and size as listed in sets.
2. Numbers used are Ives (IVE).
3. Equal products by Hager and Stanley are also acceptable.

B. Continuous Gear Hinge:

1. 6063-T6 aluminum alloy, anodized finish (cap on entire hinge painted if specified). Manufacture to template, uncut hinges non-handed, pinless assembly, three interlocking extrusions, full height of door and frame, fasteners 410 stainless steel plated and hardened. Anodizing of material shall be done after fabrication of components so that all bearing slots are anodized.
2. Length: 1" less than door opening height. Fastener 12-24 x 1/2" #3 Phillips keen form stainless steel self-tapping at aluminum and hollow metal doors, 12- 1/2" #3 Philips, flathead full thread at wood doors.
3. Furnish fire rated hinges "FR" at labeled openings.
4. Numbers used are Ives.
   a. For Aluminum frames;
      1) Ives 112XY

2) Equal products by Hager & Select will also be accepted.

C. Locksets and Latchsets - Mortise Type:

1. Locksets shall be manufactured from heavy gauge steel, minimum lockcase thickness 1/8", containing components of steel with a zinc dichromate plating for corrosion resistance.
2. Locks are to have a standard 2 ¾" backset with a full ¾" throw two-piece stainless steel mechanical anti-friction latchbolt. Deadbolt shall be a full 1" throw, constructed of stainless steel.
3. Lockcase shall be easily handed without chassis disassembly by removing handing screw on lockcase and installing in opposite location on reverse side. Changing of door hand bevel from standard to reverse hand shall be done by removing the lockcase scalp plate, and pulling and rotating the latchbolt 180 degrees.
4. Lock trim shall be through-bolted to the door to assure correct alignment and proper operation. Lever trim shall have external spring cage mechanism to assist in support of the lever weight. Thumb turns shall have "EZ" thumbturn equal to Schlage L583-363.
5. Function numbers are Schlage.
   a. Schlage L9000
6. Lockset Trim:
   a. Schlage 03A
7. Provide strikes with extended lips where required to protect trim from being marred by latch bolt. Provide strike lips that do not project more than 1/8" beyond door frame trim at single doors and have 7/8" lip to center at pairs of 1-3/4" doors.

D. Exit Devices:

1. Exit devices shall be touchpad style, fabricated of brass, bronze, stainless steel, or aluminum, plated to the standard architectural finishes to match the balance of the door hardware.
2. All exit devices shall incorporate a fluid damper, which decelerates the touchpad on its return stroke and eliminates noise associated with exit device operation. Touchpad shall extend a minimum of one half of the door width. All latchbolts to be deadlatching type, with a self-lubricating coating to reduce wear.
3. End-cap will be sloped to deflect any impact from carts and they shall be flush with the external mechanism case. End caps that overlap and project above the mechanism case are unacceptable. End cap shall utilize a two-point attachment to the mounting bracket.
4. Touchpad shall match exit device finish, and shall be stainless steel for US26, US26D, US28, US32, and US32D finishes. Only compression springs will be used in devices, latches, and outside trims or controls.
5. Plastic templates shall be included with each exit device to facilitate a quick, easy and accurate installation.
6. Strikes shall be roller type and come complete with a locking plate to prevent movement.

7. All rim and vertical rod exit devices shall have passed a 5 million(5,000,000) cycle test based on ANSI A156.3, 1994, Grade 1 test standards and certified by an independent testing lab.
8. All mortise exit devices shall have passed a 10 million(10,000,000)cycle test based on ANSI A156.3, 1994, Grade 1 test standards and certified by an independent testing lab.
9. Provide cylinder dogging on panic exit hardware where noted in hardware sets.
10. Exit devices shall be UL listed panic exit hardware. All exit devices for fire rated openings shall be UL labeled fire exit hardware.
11. Lever trim for exit devices shall be vandal-resistant type, which will travel to a 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.
12. Von Duprin 98 Series. Series and function numbers as listed in sets.
13. Trim:
    a. As specified in sets.
    b. Levers to match lockset design where specified.

E. Removable Mullion:
    a. Mullion is removable only through the use of building keys.
        1) Von Duprin KR4954

F. Push and Pull Hardware:

1. Push Plates: Ives 8200 Series 3-1/2 x 15 x .050 inches.
2. Pull, Offset: One inch round rod, 90 degree offset, 12 inch centers.
3. Pull Plates: Ives 8302-8 3-1/2 x 15 x .050 inches. 8" center.
4. Manufacturer: Provide push and pull hardware from any member of B.H.M.A.

G. Closers:

1. Door closers shall have fully hydraulic, full rack and pinion action with a high strength cast iron cylinder. Cylinder body shall be 1 ½" in diameter, and double heat treated pinion shall be 11/16" in diameter with double D slab drive arm connection.
2. Hydraulic fluid shall be of a type requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to –30 degrees F.
3. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed, and backcheck.
4. All closers shall have solid forged steel main arms (and forged forearms for parallel arm closers).
5. All surface mounted mechanical closers shall be certified to exceed ten million (10,000,000) full load cycles by a recognized independent testing laboratory.
6. Closers will have Powder coating finish certified to exceed 100 hours salt spray testing by ETL, an independent testing laboratory used by BHMA for ANSI certification.
7. Refer to door and frame details and furnish accessories such as drop plates, panel adapters, spacers and supports as required to correctly install door closers. State degree of door swing in the hardware schedule.

8. LCN Series as listed in sets.

H. Overhead Holders and Stops:

1. Type, function and fasteners must be same as Glynn-Johnson specified. Size per manufacturer's selector chart. Plastic end caps, hold open mechanisms and shock blocks are not allowed. End caps must be finished same as balance of unit.
2. Manufacture products using base material of Brass/Bronze for US3, US4, & US10B finished products and 300 Stainless Steel for US32 & US32D finished products.
3. Type, function, and fasteners must be the same as Glynn-Johnson specified. Size per manufacturer's selector chart.
   a. Glynn-Johnson

I. Kick Plates:

1. Furnish .050 inches thick, beveled four sides, countersunk fasteners, 10" high x door width less 2" at single doors and less 1" at pairs. Where glass or louvers prevent this height, supply with height equal to height of bottom rail less 2".
2. Any BHMA manufacturing product meeting above is acceptable.

J. Wall Stops:

1. Length to exceed projection of all other hardware. **Provide with threaded studs and expansion shields for masonry wall construction**.
   a. Ives WS33(X)
   b. BHMA L12011 or L12021

K. Wall Stop/Holders:

1. Products specified by series only; furnish strike length to exceed projection of all other hardware. **Provide with threaded studs and expansion shields for masonry wall construction.**
   a. Ives WS40
   b. Equal products of any BHMA manufacturer

L. Thresholds:

1. 1/2" high - 5" wide. Cope at jambs.
2. Furnish full wall opening width when frames are recessed.
3. Cope in front of mullions if thresholds project beyond door faces.
4. Furnish with non-ferrous Stainless Steel Screws and Lead Anchors.
   a. Zero as listed in sets
   b. Equal of NGP or Reese

M. Door Sweeps:

1. Surface Sweeps:
   a. Zero as listed in sets
   b. Equal of NGP or Reese

N. Miscellaneous:

1. Furnish items not categorized in the above descriptions but specified by manufacturer's names in Hardware Sets.

O. Fasteners:

1. Furnish fasteners of the proper type, size, quantity and finish. Use machine screws and expansion shields for attaching hardware to concrete or masonry, and wall grip inserts at hollow wall construction. Furnish machine screws for attachment to reinforced hollow metal doors and frames and reinforced aluminum doors and frames. Furnish full thread wood screws for attachment to solid wood doors and frames. "TEK" type screws are not acceptable.
2. **Sex bolts will not be permitted on reinforced metal doors or wood doors where blocking is specified.**

2.3 FINISHES:

A. Generally, Dull Chrome, US26D / BHMA 626. Provide finish for each item as indicated in sets.

2.4 TEMPLATES AND HARDWARE LOCATION:

A. Furnish hardware made to template. Supply required templates and hardware locations to the door and frame manufacturers.

B. Furnish metal template to frame/door supplier for continuous hinge.

C. Refer to Article 3.1 B.2, Locations, and coordinate with templates.

2.5 CYLINDERS AND KEYING:

A. All cylinders for this project will be supplied by one supplier regardless of door type and location.

B. The Finish Hardware supplier will meet with Architect and/or Owner to finalize keying requirements and obtain keying instructions in writing.
1. Supplier shall include the cost of this service in his proposal.

C. Provide a cylinder for all hardware components capable of being locked.

D. Provide cylinders master and grand master keyed to existing Best system according to Owner's instructions. Provide change keys, master keys and grand master keys as required by Owner.

E. Provide cylinders with construction cores or keying for use during the construction period. When so directed, and in the presence of the Owner's security department or representative, convert construction cores or keying to the final system.

1. Supplier shall include the cost of this service in his proposal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install hardware according to manufacturers installations and template dimensions. Attach all items of finish hardware to doors, frames, walls, etc. with fasteners furnished and required by the manufacture of the item.
2. Provide blocking/reinforcement for all wall mounted Hardware.
3. Reinforced hollow metal doors and frames and reinforced aluminum door and frames will be drilled and tapped for machine screws.
4. Solid wood doors and frames: full thread wood screws. Drill pilot holes before inserting screws.
5. Continuous gear hinges attached to hollow metal doors and frames and aluminum doors and frames: 12-24 x 1/2" #3 Phillips Keenform self-tapping. Use #13 or 3/16 drill for pilot.
6. Continuous Gear Hinges require continuous mortar guards of foam or cardboard 1/2" thick x frame height, applied with construction adhesive.
7. Install weather-strip gasket prior to parallel arm closer bracket, rim exit device or any stop mounted hardware. Gasket to provide a continuous seal around perimeter of door opening. Allow for gasket when installing finish hardware. Door closers will require special templating. Exit devices will require adjustment in backset.

B. Locations:

1. Dimensions are from finish floor to center line of items.
2. Include this list in Hardware Schedule.

CATEGORY	DIMENSION
Hinges	Door Manufacturer's Standard
Levers	Door Manufacturer's Standard
Exit Device Touchbar	Per Template
Offset Pulls	Suitable for Exit Devices
Push Plates	52"
Pull Plates	42"
Wall Stops/Holders	At Head

C. Field Quality Inspection:

1. Inspect material furnished, its installation and adjustment, and instruct the Owner's personnel in adjustment, care and maintenance of hardware.
2. Locksets and exit devices shall be inspected after installation and after the HVAC system is in operation and balanced, to insure correct installation and proper operation.

3. Closers shall be inspected and adjusted after the HVAC system is in operation and balanced, to insure correct installation and proper operation.
4. A written report stating compliance, and also locations and kinds of noncompliance shall be forwarded to the Architect with copies to the Contractor, hardware distributor, hardware installer and building owner.

D. Technical and Warranty Information:

1. At the completion of the project, the technical and warranty information coalesced and kept on file by the General Contractor/Construction Manager shall be given to the Owner or Owner's Agent. In addition to both the technical and warranty information, all factory order acknowledgement numbers supplied to the General Contractor/Construction Manager during the construction period shall be given to the Owner or Owner's Agent. The warranty information and factory order acknowledgement numbers shall serve to both expedite and properly execute any warranty work that may be required on the various hardware items supplied on the project.
2. Submit to General Contractor/Construction Manager, two copies each of parts and service manuals and two each of any special installation or adjustment tools. Include for locksets, exit devices, door closers and any electrical products.

3.2 HARDWARE SETS:

Hardware Group No. 01
EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY	628	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544 L283-711	626	SCH
1	EA	OH STOP	100S	630	GLY
1	EA	SURFACE CLOSER	4021	689	LCN
1	EA	MOUNTING PLATE	4020-18G	689	LCN

Hardware Group No. 02
EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A	626	SCH
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS33	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 03

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A	626	SCH
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS33	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 04

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
2	EA	DUMMY PUSH BAR	350	626	VON
2	EA	90 DEG OFFSET PULL	8190EZHD 12" O	630-316	IVE
2	EA	OH STOP	100S	630	GLY
2	EA	SURFACE CLOSER	4021	689	LCN
2	EA	MOUNTING PLATE	4020-18G	689	LCN

Hardware Group No. 05

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A	626	SCH
1	EA	OH STOP	90S	652	GLY
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 06

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	PANIC HARDWARE	9827-DT-LBR	626	VON
1	EA	PANIC HARDWARE	9827-NL-LBR	626	VON
1	EA	SFIC RIM HOUSING	80-129	626	SCH
2	EA	SURFACE CLOSER	4111 EDA	689	LCN
2	EA	PROTECTION PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP/HOLDER	WS40	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
2	EA	MEETING STILE SEAL	8194AA	AA	ZER

Hardware Group No. 07

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW4	✓	652	IVE
1	EA	EU MORTISE LOCK	L9092BDCEU 03A RX CON 12/24 VDC	✓	626	SCH
1	EA	SURFACE CLOSER	4111 EDA		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
1	EA	CREDENTIAL READER	S-DOOR-KIT-WH	✓		
1	EA	DOOR CONTACT	2507AH-L	✓		
1	EA	POWER SUPPLY	PS902 900-2RS		LGR	VON

PRESENTING AN AUTHORIZED CREDENTIAL WILL UNLOCK THE OUTSIDE LEVER AND ALLOW ACCESS. FREE EGRESS IS ALWAYS ALLOWED. THE SYSTEM WILL BE INSTALLED AND WILL OPERATE PER ALL APPLICABLE CODES.

COORDINATE SYSTEM OPERATION AND COMPOENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 08

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	PUSH PLATE	8200 3.5" X 15"	630	IVE
1	EA	PULL PLATE	8302 8" 3.5" X 15"	630	IVE
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS33	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 09

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	SET	GASKETING	870AA-S	AA	ZER
1	EA	AUTO-DOOR BOTTOM	368AA	AA	ZER
1	EA	THRESHOLD	63A-223	A	ZER

INSTALL THRESHOLD TO ALLOW PROPER SEAL OF THE AUTOMATIC DOOR BOTTOM.

Hardware Group No. 10

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	PASSAGE SET	L9010 03A		626	SCH
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 11

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	PASSAGE SET	L9010 03A		626	SCH
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 12

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW4	↯	652	IVE
1	EA	ELEC FIRE EXIT HARDWARE	RX-QEL-98-NL-F 24 VDC	↯	626	VON
1	EA	SFIC RIM HOUSING	80-129		626	SCH
1	EA	SURFACE CLOSER	4111 EDA		689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS33		626	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
1	EA	CREDENTIAL READER	S-DOOR-KIT-WH	↯		
1	EA	DOOR CONTACT	2507AH-L	↯		
1	EA	POWER SUPPLY	PS902 900-2RS		LGR	VON

180 DEGREE SWING.

PRESENTING AN AUTHORIZED CREDENTIAL WILL UNLOCK THE OUTSIDE LEVER AND ALLOW ACCESS. FREE EGRESS IS ALWAYS ALLOWED. THE SYSTEM WILL BE INSTALLED AND WILL OPERATE PER ALL APPLICABLE CODES.

COORDINATE SYSTEM OPERATION AND COMPOENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 13

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PASSAGE SET	L9010 03A	626	SCH
1	EA	SURFACE CLOSER	4011 SRI	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 14

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A	626	SCH
1	EA	OH STOP	90S	652	GLY
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 15

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A	626	SCH
1	EA	OH STOP	90S	652	GLY
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 16

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544 L283-711	626	SCH
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 17

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A	626	SCH
1	EA	SURFACE CLOSER	4111 EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 18

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A	626	SCH
1	EA	SURFACE CLOSER	4111 EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 19

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 20

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 21

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA		801		PLA	LCN
2	EA	CONT. HINGE	112XY TWP CON	✓	628	IVE
1	EA	REMOVABLE MULLION	KR4954 STAB		689	VON
1	EA	ELEC PANIC HARDWARE	HD-LX-RX-QEL-98-NL-OP-110MD 24 VDC	✓	626	VON
1	EA	ELEC PANIC HARDWARE	RX-98-EO	✓	626	VON
1	EA	SFIC MORTISE CYL.	80-102		626	SCH
1	EA	SFIC RIM HOUSING	80-129		626	SCH
2	EA	90 DEG OFFSET PULL	8190EZHD 12" O		630-316	IVE
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100SE		630	GLY
1	EA	SURFACE CLOSER	4021		689	LCN
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	✓	689	LCN
1	EA	MOUNTING PLATE	4020-18G		689	LCN
1	EA	ACTUATOR, TOUCH	8310-818T	✓	630	LCN
1	EA	ACTUATOR, TOUCH	8310-853T	✓	630	LCN
1	SET	WEATHER SEAL	(PROVIDED BY THE DOOR & FRAME MFR)			
1	EA	MULLION SEAL	8780NBK PSA		BK	ZER
2	EA	DOOR SWEEP	8198AA		AA	ZER
1	EA	THRESHOLD	545A-223		A	ZER
1	EA	CREDENTIAL READER	S-DOOR-KIT-WH	✓		
2	EA	DOOR CONTACT	2507AH-L	✓		
1	EA	POWER SUPPLY	PS902 900-2RS		LGR	VON

PRESENTING AN AUTHORIZED CREDENTIAL WILL RETRACT THE LATCHBOLT OF ONE EXIT DEVICE AND ENABLE THE EXTERIOR AUTOMATIC OPERATOR ACTUATOR AND ALLOW ACCESS. FREE EGRESS IS ALWAYS ALLOWED. THE VESTIBULE MOUNTED ACTUATOR IS ALWAYS ENABLED. COORDINATE OPERATION WITH THE INTERIOR DOOR AUTOMATIC OPERATOR. COORDINATE SYSTEM OPERATION AND COMPONENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 22

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE

Hardware Group No. 24

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112XY		628	IVE
2	EA	DUMMY PUSH BAR	350		626	VON
2	EA	90 DEG OFFSET PULL	8190EZHD 12" O		630-316	IVE
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100SE		630	GLY
1	EA	SURFACE CLOSER	4021		689	LCN
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	↯	695	LCN
1	EA	MOUNTING PLATE	4020-18G		689	LCN
1	EA	ACTUATOR, TOUCH	8310-818T	↯	630	LCN
1	EA	ACTUATOR, TOUCH	8310-853T	↯	630	LCN

THE AUTOMATIC OPERATOR ACTUATORS ARE ALWAYS ENABLED.
COORDINATE SYSTEM OPERATION AND COMPONENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 25

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	PRIVACY W/COIN TURN	L9044 03A 09-544 L283-722	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 26

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
1	EA	OH STOP	90S J	652	GLY
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 27

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 28

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544		626	SCH
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 29

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	PANIC HARDWARE	98-NL		626	VON
1	EA	SFIC RIM HOUSING	80-129		626	SCH
1	EA	SURFACE CLOSER	4111 EDA		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS33		626	IVE

Hardware Group No. 30

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112XY TWP CON	✓	628	IVE
1	EA	REMOVABLE MULLION	KR4954 STAB		689	VON
1	EA	ELEC PANIC HARDWARE	HD-RX-QEL-98-NL-OP-110MD 24 VDC	✓	626	VON
1	EA	ELEC PANIC HARDWARE	RX-98-EO	✓	626	VON
1	EA	SFIC MORTISE CYL.	80-102		626	SCH
1	EA	SFIC RIM HOUSING	80-129		626	SCH
2	EA	90 DEG OFFSET PULL	8190EZHD 12" O		630-316	IVE
2	EA	OH STOP	100S		630	GLY
2	EA	SURFACE CLOSER	4021		689	LCN
2	EA	MOUNTING PLATE	4020-18G		689	LCN
1	SET	WEATHER SEAL	(PROVIDED BY THE DOOR & FRAME MFR)			
1	EA	MULLION SEAL	8780NBK PSA		BK	ZER
2	EA	DOOR SWEEP	8198AA		AA	ZER
1	EA	THRESHOLD	545A-223		A	ZER
1	EA	CREDENTIAL READER	S-DOOR-KIT-WH	✓		
2	EA	DOOR CONTACT	2507AH-L	✓		
1	EA	POWER SUPPLY	PS902 900-2RS		LGR	VON

PRESENTING AN AUTHORIZED CREDENTIAL WILL RETRACT THE LATCHBOLT OF ONE EXIT DEVICE AND ALLOW ACCESS. FREE EGRESS IS ALWAYS ALLOWED.

COORDINATE SYSTEM OPERATION AND COMPONENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 31

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544		626	SCH
1	EA	SURFACE CLOSER	4111 EDA		689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 32

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544		626	SCH
1	EA	SURFACE CLOSER	4111 EDA		689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 33

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	224XY TWP CON	↯	628	IVE
1	EA	EU MORTISE LOCK	L9092BDCEU 03A RX CON 12/24 VDC	↯	626	SCH
1	EA	OH STOP	90S		652	GLY
1	EA	SURFACE CLOSER	4011		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	SET	GASKETING	429AA-S		AA	ZER
1	EA	GASKETING	488SBK PSA		BK	ZER
1	EA	DOOR SWEEP	8198AA		AA	ZER
1	EA	THRESHOLD	545A-223		A	ZER
1	EA	CREDENTIAL READER	S-DOOR-KIT-WH	↯		
1	EA	DOOR CONTACT	2507AH-L	↯		
1	EA	POWER SUPPLY	PS902 900-2RS		LGR	VON

PRESENTING AN AUTHORIZED CREDENTIAL WILL UNLOCK THE OUTSIDE LEVER AND ALLOW ACCESS. FREE EGRESS IS ALWAYS ALLOWED. THE SYSTEM WILL BE INSTALLED AND WILL OPERATE PER ALL APPLICABLE CODES.

COORDINATE SYSTEM OPERATION AND COMPOENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 34

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW4	✓	652	IVE
1	EA	EU MORTISE LOCK	L9092BDCEU 03A RX CON 12/24 VDC	✓	626	SCH
1	EA	SURFACE CLOSER	4011		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS33		626	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
1	EA	CREDENTIAL READER	S-DOOR-KIT-WH	✓		
1	EA	DOOR CONTACT	2507AH-L	✓		
1	EA	POWER SUPPLY	PS902 900-2RS		LGR	VON

PRESENTING AN AUTHORIZED CREDENTIAL WILL UNLOCK THE OUTSIDE LEVER AND ALLOW ACCESS. FREE EGRESS IS ALWAYS ALLOWED. THE SYSTEM WILL BE INSTALLED AND WILL OPERATE PER ALL APPLICABLE CODES.

COORDINATE SYSTEM OPERATION AND COMPOENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 35

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112XY TWP CON	✓	628	IVE
1	EA	REMOVABLE MULLION	KR4954 STAB		689	VON
2	EA	ELEC PANIC HARDWARE	RX-98-EO	✓	626	VON
1	EA	SFIC MORTISE CYL.	80-102		626	SCH
2	EA	90 DEG OFFSET PULL	8190EZHD 12" O		630-316	IVE
2	EA	OH STOP	100S		630	GLY
2	EA	SURFACE CLOSER	4021		689	LCN
2	EA	MOUNTING PLATE	4020-18G		689	LCN
1	SET	WEATHER SEAL	(PROVIDED BY THE DOOR & FRAME MFR)			
1	EA	MULLION SEAL	8780NBK PSA		BK	ZER
2	EA	DOOR SWEEP	8198AA		AA	ZER
1	EA	THRESHOLD	545A-223		A	ZER
2	EA	DOOR CONTACT	2507AH-L	✓		

DOOR POSITION MAY BE MONITORED. FREE EGRESS IS ALWAYS ALLOWED.

COORDINATE SYSTEM OPERATION AND COMPONENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 36

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
1	EA	SURFACE CLOSER	4111 CUSH	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 37

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY	628	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544 L283-711	626	SCH
1	EA	OH STOP & HOLDER	100H	630	GLY
1	EA	SURFACE CLOSER	4011	689	LCN

Hardware Group No. 38

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544 L283-711	626	SCH
1	EA	SURFACE CLOSER	4111 EDA	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 39

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
2	EA	PUSH/PULL BAR	9190EZHD-12"-NO	630-316	IVE
2	EA	OH STOP	100S	630	GLY
2	EA	SURFACE CLOSER	4011	689	LCN

Hardware Group No. 40

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY	628	IVE
1	EA	DUMMY PUSH BAR	350	626	VON
1	EA	90 DEG OFFSET PULL	8190EZHD 12" O	630-316	IVE
1	EA	OH STOP	100S	630	GLY
1	EA	SURFACE CLOSER	4021	689	LCN
1	EA	MOUNTING PLATE	4020-18G	689	LCN

Hardware Group No. 41

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	MANUAL FLUSH BOLT	FB458 (22" TOP / 12" BOTTOM)	626	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
2	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 42

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	CONST LATCHING BOLT	FB51T	630	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A	626	SCH
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	OH STOP	90S	652	GLY
2	EA	SURFACE CLOSER	4011	689	LCN
2	EA	PROTECTION PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 43

EACH TO HAVE:

QTY	DESCRIPTION	CATALOG NUMBER (ALL HDWE BY DOOR MFR)	FINISH	MFR

Hardware Group No. 44

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	SET	CONST LATCHING BOLT	FB52	630	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	SURFACE CLOSER	4021	689	LCN
2	EA	MOUNTING PLATE	4020-18G	689	LCN
2	EA	PROTECTION PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 45

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	SET	CONST LATCHING BOLT	FB52		630	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A		626	SCH
1	EA	COORDINATOR	COR X FL		628	IVE
2	EA	MOUNTING BRACKET	MB		689	IVE
2	EA	OH STOP	90S		652	GLY
2	EA	SURFACE CLOSER	4011		689	LCN
2	EA	PROTECTION PLATE	8400 10" X 1" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 46

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	224XY		628	IVE
1	EA	CONT. HINGE	224XY TWP CON	↯	628	IVE
1	SET	CONST LATCHING BOLT	FB51P		630	IVE
1	EA	STOREROOM LOCK	L9080BDC LLL 03A L283-150		626	SCH
1	EA	ELECTRIC STRIKE	6223 FSE DS	↯	630	VON
1	EA	LOCK GUARD	LG14		630	IVE
1	EA	DOOR PULL	VR900 LLP		630	IVE
1	EA	COORDINATOR	COR X FL		628	IVE
2	EA	OH STOP	100S		630	GLY
2	EA	SURFACE CLOSER	4021 SRI		689	LCN
2	EA	MOUNTING PLATE	4020-18G		689	LCN
1	SET	GASKETING	429AA-S		AA	ZER
2	EA	DOOR SWEEP	8198AA		AA	ZER
1	EA	THRESHOLD	545A-223		A	ZER
1	EA	CREDENTIAL READER	S-DOOR-KIT-WH	↯		
2	EA	DOOR CONTACT	2507AH-L	↯		
1	EA	POWER SUPPLY	PS902 900-2RS		LGR	VON

PRESENTING AN AUTHORIZED CREDENTIAL WILL ENERGIZE THE ELECTRIC STRIKE TO ALLOW ACCESS. FREE EGRESS IS ALWAYS ALLOWED.

COORDINATE SYSTEM OPERATION AND COMPONENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 47

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	SET	CONST LATCHING BOLT	FB52		630	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A		626	SCH
1	EA	COORDINATOR	COR X FL		628	IVE
2	EA	MOUNTING BRACKET	MB		689	IVE
2	EA	SURFACE CLOSER	4111 CUSH		689	LCN
2	EA	PROTECTION PLATE	8400 10" X 1" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 48

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	SET	CONST LATCHING BOLT	FB52		630	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A		626	SCH
1	EA	COORDINATOR	COR X FL		628	IVE
2	EA	MOUNTING BRACKET	MB		689	IVE
2	EA	SURFACE CLOSER	4111 CUSH		689	LCN
2	EA	PROTECTION PLATE	8400 10" X 1" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 49

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	224XY		628	IVE
1	EA	STOREROOM LOCK	L9080BDC LLL 03A L283-150		626	SCH
1	EA	ELECTRIC STRIKE	6210 FSE DS	↯	630	VON
1	EA	LOCK GUARD	LG14		630	IVE
1	EA	DOOR PULL	VR900 LLP		630	IVE
1	EA	SURFACE CLOSER	4111 SHCUSH MCSRI		689	LCN
1	SET	GASKETING	429AA-S		AA	ZER
1	EA	DOOR SWEEP	8198AA		AA	ZER
1	EA	THRESHOLD	545A-223		A	ZER
1	EA	CREDENTIAL READER	S-DOOR-KIT-WH	↯		
1	EA	DOOR CONTACT	2507AH-L	↯		
1	EA	POWER SUPPLY	PS902 900-2RS		LGR	VON

PRESENTING AN AUTHORIZED CREDENTIAL WILL ENERGIZE THE ELECTRIC STRIKE TO ALLOW ACCESS. FREE EGRESS IS ALWAYS ALLOWED.

COORDINATE SYSTEM OPERATION AND COMPONENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 50

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	PUSH PLATE	8200 3.5" X 15"	630	IVE
1	EA	PULL PLATE	8302 8" 3.5" X 15"	630	IVE
1	EA	SURFACE CLOSER	4111 EDA	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS33	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 51

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
2	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 52

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
2	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 53

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 5 X 4.5 NRP	652	IVE
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
2	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 54

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

END OF SECTION 08 7100

SECTION 08 8000
GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Glass and glazing for interior and exterior windows and doors.
B. Fire Protection Rated Glazing for use in rated assemblies.

1.3 REFERENCES

A. ANSI Z97.1 – Safety Performance Specifications and Methods of Test for Safety Glazing Used in Buildings.
B. ASTM C1036 – Flat Glass.
C. ASTM C1048 – Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
D. FGMA – Glazing Manual.
E. FGMA – Sealant Manual.
F. Laminators Safety Glass Association – Standards manual.

1.4 PERFORMANCE REQUIREMENTS

A. Glass and glazing materials of this Section shall provide continuity of enclosure, sound, vapor and air barrier.
B. Size glass to withstand dead loads and positive and negative live loads acting normal to plane of glass as calculated in accordance with governing code, as measured in accordance with ANSI/ASTM E330.
C. Limit glass deflection to 1/200 or flexure limit of glass with full recovery of glazing materials, whichever is less.

1.5 SUBMITTALS

A. Product Data on Glass Types Specified: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
B. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors.
C. Manufacturer's Installation Instructions: Indicate special precautions required.
D. Tinted Insulated Glass sample to confirm match to existing exterior glazing.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with FGMA Glazing Manual, FGMA Sealant Manual, and Laminators Safety Glass Association – Standards Manual for glazing installation methods.
B. Safety Glazing Standard: Where safety glass is indicated or required by authorities having jurisdiction, provide type of products indicated which comply with ANSI Z 97.1, testing requirements of 16 CFR Part 1201 for category II materials, and as indicated herein.
C. Fire-Resistive Glazing Products: Provide products identical to those tested in compliance with ASTM E 152, labeled and listed UL or another

testing and inspecting agency acceptable to authorities having jurisdiction.

D. Single Source Responsibility for Materials: To ensure consistent quality of appearance and performance, provide materials produced by a single manufacturer for each kind and condition of material indicated.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Maintain room ambient temperature before, during and 24 hours after installation of glazing compounds.

1.8 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on Shop Drawings.

1.9 COORDINATION

A. Coordinate the Work with glazing frames, wall openings, and perimeter air and vapor seal to adjacent Work.

1.10 WARRANTY

A. Provide ten year manufacturer's warranty.

B. Warranty: Include coverage for delamination of laminated glass and replacement of same.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Float and Heat-Treated Glass
   1. AFGD Glass
   2. Guardian Industries
   3. PPG Industries
   4. Viracon
   5. Interpane

B. Fire Protection rated Glazing
   1. Technical Glass Products.

2.2 GLASS PRODUCTS, GENERAL

A. Primary Glass Standard: Provide primary glass which complies with ASTM C 1036 requirements, including those indicated by reference to type, class, quality, and if applicable, form, finish, mesh and pattern.

B. Heat-Treated Glass Standard: Provide heat-treated glass which complies with ASTM C 1048 requirements, including those indicated by reference to kind, condition, type, quality, class and if applicable, form, finish and pattern.

C. Sizes: Fabricate glass to sizes required for glazing openings indicated, with edge clearances and tolerances complying with recommendations of glass manufacturer.

2.3 PRIMARY GLASS PRODUCTS

A. Clear Float Glass: Type I (transparent glass, flat), Class I (clear), Quality q3 (glazing select).

2.4 HEAT-TREATED GLASS PRODUCTS

A. Manufacturing Process: Manufacturer heat-treated glass by horizontal (roller hearth) process with roll wave distortion parallel with bottom edge of glass as installed.

B. Uncoated Clear Heat-Treated Float Glass: Condition A (uncoated surfaces), Type I (transparent glass, flat), Class I (clear), Quality q3 (glazing select), Kinds FT (fully tempered) and HS (heat strengthened).

2.5 INSULATED GLASS ASSEMBLIES

A. Design standard: Guardian Glass, Sunguard, Superneutral 54 insulating glass units. Clear outboard and inboard lites with SN 54 coating on the number 2 surface. Heat strengthen outboard lite as required to resist thermal stress.
B. Air space minimum ½", purged and hermetically sealed, with elastomer edge seal.

2.6 CERAMIC SPANDREL GLASS

A. ASTM C1048 Kind FT Fully tempered, Condition B one surface coated, Type II pattern flat, Class 3 tinted light reducing, Quality q7 decorative, Bronze color, minimum ¼ inch thickness unless otherwise required.

2.7 FIRE PROTECTION RATED GLAZING

A. TGP Firelite ultra HD premium grade with both surfaces polished for maximum clarity. Clear, ceramic flat glass 3/16 inch thick unless otherwise recommended by manufacturer, complying with testing requirements in 16 CFR 1201 for Category II materials, labeled by a testing agency for door and window assemblies with ratings listed on the drawings.
B. TGP Firelite Plus ultra HD premium 5/16" laminated impact safety-rated glazing material for safety glass locations.

2.8 SAFETY GLASS PRODUCTS

A. Clear fully tempered and laminated with 0.60 inch thick polyvinyl butyryl interlayer; conforming to ANSI Z 97.1. Typically ¼ inch nominal overall thickness. Except use nominal overall thickness of ¾ inch at cashier stations glazing.

2.9 ACCEPTABLE GLAZING COMPOUNDS

A. Butyl Sealant: FS TT-S-001657; Shore A hardness of 10-20 black color; non-skinning.
B. Polyurethane Sealant: FS TT-S-00230, Type II –non-sag, Class A; single component; harness range 20 to 35.
C. Silicone Sealant: Single component, chemical curing; capable of water immersion without loss of properties; non-bleeding, non-staining; cured Shore A hardness of 15-25; color as selected by Architect-Engineer.

2.10 GLAZING ACCESSORIES

A. Setting Blocks: Neoprene, 80-90 Shore A durometer hardness, length of 0.1 inch for each square foot of glazing or minimum 4 inch x width of glazing rabbet space minus 1/16 inch x height to suit glazing method and pane weight and area.
B. Spacer Shims: Neoprene, 50-60 Shore A durometer hardness, minimum 3 inch long x one half the height of the glazing stop x thickness to suit application, self adhesive on one face.
C. Glazing Tape: Preformed butyl compound with integral resilient tube spacing device; 10-15 Shore A durometer hardness; coiled on release paper; black color.
D. Glazing Splines: Resilient polyvinyl chloride extruded shape to suit

glazing channel retaining slot; color as selected by Architect-Engineer.

E. Glazing Clips: Manufacturer's standard type.

F. Aluminum Brake metal for faux mullion partition closure. Refer to detail on drawings

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that openings for glazing are correctly sized and within tolerance.

B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions and ready to receive glazing.

3.2 PREPARATION

A. Clean contact surfaces with solvent and wipe dry.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant as required.

3.3 WET/DRY METHOD (PREFORMED TAPE AND SEALANT)

A. Cut glazing tape to length and set against permanent stops, 3/16 inch below sight line. Seal corners by butting tape and dabbing with butyl sealant.

B. Apply heel bead of butyl sealant along intersection of permanent stop with frame to complete the continuity of the air and vapor seal.

C. Place setting blocks and push against tape and heel bead of selant with sufficient pressure to attain full contact at perimeter of pane or glass unit.

D. Rest glazing on setting blocks and push against tape and heel bead of sealant with sufficient pressure to attain full contact at perimeter of pane or glass unit.

E. Install removable stops, with spacer strips inserted between glazing and applied stops, ¼ inch below sight line. Place glazing tape on glazing pane or unit with tape ¼ inch below sight line.

F. Fill gap between glazing and stop with sealant to depth equal to bite of frame on glazing, but not more than 3/8 inch below sight line.

G. Apply cap bead of sealant along void between the stop and the glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.4 QUALITY CONTROL

A. Field inspection will be performed under provisions of Division One Specifications.

B. Inspection will monitor quality of glazing.

3.5 MANUFACTURER'S FIELD SERVICES

A. Glass and glazing product manufacturers to provide field surveillance of the installation of their products.

B. Monitor and report installation procedures and unacceptable conditions.

3.6 CLEANING

A. Remove glazing materials from finish surfaces.

B. Remove labels after work is complete.

C. Clean glass of all dirt, grease, smudges, and other distractions.

3.7 PROTECTION OF FINISHED WORK

A. Protect finished work.

B. After installation, mark pane with an ‘X’ by using removable plastic tape or paste.

END OF SECTION 08 8000

SECTION 08 9000
LOUVERS

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 SECTION INCLUDES

A. Louvers and frames.
B. Sealants per Section 07 9200.
C. Bird screening.
D. Blank out sheeting.

1.3 REFERENCES

A. AMCA 500 – (Air Movement Council Association) Test Method for Louvers, Dampers, and Shutters.
B. ANSI/ASTM B221 – Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
C. ASTM A167 – Stainless and Heat-Resisting Chromium-Nickel Steel Plate.
D. ASTM A526 – Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
E. ASTM A527 – Sheet Steel, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.
F. ASTM – B209 – Aluminum-Alloy Sheet and Plate.

1.4 SYSTEM PERFORMANCE

A. Installed louver to permit passage of air velocity noted on Drawings without blade vibration or noise, with maximum static pressure loss noted on Drawings.
B. Fabricate louver to permit minimum of 57 percent free area unless noted otherwise.

1.5 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacture of AMCA certified louvers with five years experience.

1.6 SUBMITTALS

A. Submit Shop Drawings and Product Data under provisions of Section 01 3300.
B. Indicate on Shop Drawings, layout, elevations, dimensions, and tolerances; head, jamb, and sill details; blade configuration; screening; and frames.
C. Provide Product Data on preassembled louvers describing design characteristics, maximum recommended air velocity, free area, materials, and finishes.
D. Submit samples under provisions of Section 01 3300.

E. Submit three samples 6x6 inch in size illustrating finish and color of exterior and interior prefinish.
F. Submit manufacturer's installation instructions under provisions of Section 01 3300.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Section 01 7300.
B. Include lubrication schedules, and adjustment requirements.

1.8 COORDINATION

A. Coordinate work of this Section with installation of flashings.
B. Coordinate work of this Section with mechanical ductwork.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design: Ruskin's, Model ELF6375DX.
B. Construction Specialties, Inc.'s, approved equivalent.
C. Airolite's approved equivalent.

2.2 MATERIALS

A. Aluminum: ANSI/ASTM B221, 6063-T5 aluminum alloy, temper; extruded shape, ASTM B209, aluminum alloy, temper, sheet, prefinished with mill applied Kynar 500 or Hylar 5000 flurocarbon baked enamel paint finish; custom color.
B. Fasteners and Anchors: Stainless steel type.

2.3 ACCESSORIES

A. Bird Screen: 18x16 size aluminum mesh, set in aluminum frame.
B. Flashings: Of same material as louver frame. Sheet steel. Aluminum.
C. Sealants: Type specified in Section 07 9200.

2.4 FABRICATION

A. Louver Size: 5 inches deep, face measurements as indicated on Drawings.
B. Louver Blade: Sloped at 45 degree or vertical type depending on location shown on Drawings; Inverted 'Y' shape; minimum material thickness of .081 inches and integral waterstops on blade.
C. Louver Frame: Channel shape, welded corner joints, material thickness of .081 gage.
D. Mullions: Concealed of aluminum, profiled to suit louver frame.
E. Head, Jamb, and Sill Flashings: Roll formed to required shape, one piece per location.
F. Screens: Install screen mesh in shaped frame with reinforced corner construction; screw to louver frame.
G. Blank Out Sheeting: Insulated panels with face construction of same material as louver and frame.

2.5 FINISHES

A. Exposed Aluminum Surfaces, Screens, and Exterior Surface of Blank Out Sheeting: Prepainted finish of custom Kynar 500 color as selected by Architect-Engineer.
B. Interior Aluminum Surfaces, Screens, and Blank Out Sheeting: Mill finished.

PART 3 – EXECUTION

3.1 INSPECTION

A. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on Shop Drawings.
B. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

A. Install louver assembly in accordance with manufacturer's instructions.
B. Install louvers level and plumb.
C. Secure louvers in opening framing with concealed fasteners.
D. Install flashings and align; Align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
E. Install bird screening to interior of louver. Hinge screens for access.
F. Install perimeter sealant in accordance with Section 07 9200.

3.3 CLEANING

A. Clean surfaces and components.
B. Touch up any scratched, gouged, or discolored surfaces.

END OF SECTION 08 9000

SECTION 09 2116
GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Nonload-bearing steel framing members for gypsum board assemblies.
   2. Gypsum board assemblies attached to steel framing.
   3. Steel framing for suspended ceilings to receive gypsum board.

B. Related Work Specified Elsewhere:
   1. Penetration Firestopping: Section 07 8413.
   2. Joint sealers: Section 07 9200.

1.3 DEFINITIONS

A. Gypsum Board Construction Terminology: Refer to ASTM C 11 and GA-505 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 SUBMITTALS

A. Product Data for each type of product specified.
B. Shop Drawings showing locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility for Steel Framing: Obtain steel framing members for gypsum board assemblies from a single manufacturer, unless otherwise indicated.
B. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.
C. Fire-Test-Response Characteristics: Where fire-rated gypsum board assemblies are indicated, provide materials and construction identical to those of assemblies tested for fire resistance according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Fire Resistance Ratings: As indicated by reference to GA File Numbers in GA-600 “Fire Resistance Design Manual”, to design designations in UL “Fire Resistance Directory” or in listing of another testing and inspecting agency acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or 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. Neatly stack gypsum panels flat to prevent sagging.

1.7 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.
B. Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40 deg F. For adhesive attachment and finishing of gypsum board, maintain not less than 50 deg F for 48 hours before application and continuously after until dry. Do not exceed 95 deg F when using temporary heat sources.
C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2- PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Steel Framing and Furring:
        a. Dale/Incor.
        b. Dietrich Industries, Inc.
        c. Marino/Ware.
        d. Gold Bond Building Products.
        e. Unimast, Inc.
    2. Gypsum Board and Related Products:
        a. LaFarge North America.
        b. Georgia-Pacific Corp.
        c. National Gypsum Co.; Gold Bond Building Products Division.
        d. United States Gypsum Co.

2.2 STEEL FRAMING FOR WALLS AND PARTITIONS

A. General: Provide steel framing members complying with the following requirements:
    1. Protective Coating: ASTM A 653, G 40 (ASTM A 653M, Z 90) hot-dip galvanized coating.
B. Steel Studs and Runners: ASTM C 645, with flange edges of studs bent back 90 degrees and doubled over to form 3/16-inch wide minimum lip (return), and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:
    1. Thickness: 0.0299 inch (22 ga.), unless otherwise indicated.

a. For head runner, sill runner, jamb, and cripple studs at door and other openings.
b. Where indicated.

2. Depth: 3 5/8 inches, unless otherwise indicated.

C. Deflection Track: Manufacturer's standard top runner designed to prevent cracking of gypsum board applied to interior partitions resulting from deflection of the structure above fabricated from steel sheet complying with ASTM A 653 (ASTM A 653M) or ASTM A 568 (ASTM A 568M). Thickness as indicated for studs, and width to accommodate depth of studs, and of the following configuration:

1. Top runner with 2-1/2-inch deep flanges that either have V-shaped offsets that compress when pressure is applied from construction above or have slots 1 inch o.c. that allow fasteners attached to studs through the slots to accommodate structural movement by slipping.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Superior Flex Track System (SFT); Delta Star, Inc.
      2) SLP-TRK; Metal-Lite, Inc.

D. Steel Rigid Furring Channels: ASTM C 645, hat shaped, depth and minimum thickness of base (uncoated) metal as follows:

1. Thickness: 0.0179 inch, unless otherwise indicated.
2. Depth: 7/8 inch.

E. Z-Furring Members: Manufacturer's standard Z-shaped furring members with slotted or nonslotted web, fabricated from steel sheet complying with ASTM A 653 or ASTM A 568; with a minimum base metal (uncoated) thickness of 0.0179 inch, face flange of 1-1/4 inch, wall-attachment flange of 7/8 inch, and of depth required to fit insulation thickness indicated.

F. Steel Flat Strap and Backing Plate: Steel sheet for blocking and bracing complying with ASTM A 653 or ASTM A 568, length and width as indicated, and with a minimum base metal (uncoated) thickness as follows:

1. Thickness: 0.0598 inch where indicated.

G. Fasteners for Metal Framing: Provide fasteners of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum board manufacturers for applications indicated.

H. Shaft Wall Studs: C-H or C-T Metal Studs, size shown on Drawings, roll formed galvanized steel per ASTM c645. Include all metal runners, channels, clips, accessories, etc. required for complete installation.

2.3 STEEL FRAMING COMPONENTS FOR SUSPENDED AND FURRED CEILINGS

A. General: Provide components which comply with ASTM C 754 for materials and sizes, unless otherwise indicated.

B. Wire for Hangers and Ties: ASTM A 641, Class I zinc-coating, soft temper.

C. Hanger Rods: Mild steel, zinc-coated or protected with rust-inhibitive paint.
D. Flat Hangers: Mild steel, zinc-coated or protected with rust-inhibitive paint.
E. Angle-Type Hangers: Angles with legs not less than 7/8 inch wide, formed from 0.0635 inch thick galvanized steel sheet comply with ASTM A 446, coating designation G 90, with bolted connections and 5/16 inch diameter bolts.
F. Steel Studs for Furring Channels: ASTM C 645, with flange edges bent back 90 degrees and doubled over to form 3/16 inch minimum lip (return) minimum thickness of base (uncoated) metal and minimum depth as follows:
    1. Thickness: 0.0299 inch (22 ga.), unless otherwise indicated.
    2. Depth: 3-5/8 inches, unless otherwise indicated.

2.4 GYPSUM BOARD PRODUCTS

A. General: Provide gypsum board of types indicated in maximum lengths available that will minimize end-to-end butt joints in each area indicated to receive gypsum board application.
    1. Widths: Provide gypsum board in widths of 48 inches (1219 mm).
B. Gypsum Wallboard: ASTM C 36 and as follows:
    1. Type: Regular for vertical surfaces, unless otherwise indicated (Type “X” for fire-rated assemblies).
    2. Edges: Tapered.
    3. Thickness: 5/8 inch unless otherwise noted.
C. Proprietary Abuse-Resistant Gypsum Wallboard: ASTM C 36, manufactured to produce greater resistance to surface indentation and through-penetration than standard gypsum panels. Provide on all walls to 9’-0” aff min.
    1 Products: Subject to compliance with requirements, provide one of the following:
        a. National Gypsum Company; Gold Bond Hi-Abuse Wallboard.
        b. United States Gypsum Co.; SHEETROCK Brand Abuse-Resistant Gypsum Panels.
    4. Types:
        a. Regular, unless otherwise indicated.
        b. Type X for fire-resistance rated assemblies and where indicated.
    5. Thickness: 5/8 inch, unless otherwise indicated.

2.5 TRIM ACCESSORIES

A. Accessories for Interior Installation: Corner bead, edge trim, and control joints complying with ASTM C 1047 and requirements indicated below:
    1. Material: Formed metal complying with the following requirement:
        a. Steel sheet zinc coated by hot-dip process.
        b. Shapes indicated below by reference to Fig. 1 designations in ASTM C 1047:

i. Cornerbead on outside corners, unless otherwise indicated.
ii. LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim, unless otherwise indicated.
iii. One-piece control joint formed with V-shaped slot and removable strip covering slot opening.

2.6 JOINT TREATMENT MATERIALS

A. General: Provide joint treatment materials complying with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.
B. Joint Tape for Gypsum Board: Paper reinforcing tape, unless otherwise indicated.
C. Drying-Type Joint Compounds for Gypsum Board: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.
    1. Ready-Mixed Formulation: Factory-mixed product.
        a. All-purpose compound formulated for both taping and topping compounds.

2.7 ACOUSTICAL SEALANT

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following requirements.
    1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM C 90.
B. Products: Subject to compliance with requirements, provide one of the following:
    1. Acoustical Sealant for Exposed and Concealed Joints:
        a. PL Acoustical Sealant; ChemRex Inc.; Contech Brands.
        b. AC-20 FTR Acoustical and Insulation Sealant; Pecora Corp.
        c. SHEETROCK Acoustical Sealant; United States Gypsum Co.

2.8 MISCELLANEOUS MATERIALS

A. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.
B. Grout: ASTM C 475, setting-type joint compound recommended for grouting hollow metal door frames.
C. Sound-Attenuation Blankets: Unfaced mineral-fiber blanker insulation produced by combing mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing).
    1. Mineral-Fiber Type: Fibers manufactured from glass.

PART 3- EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLING STEEL FRAMING, GENERAL

A. Steel Framing Installation Standard: Install steel framing to comply with ASTM C 754 and with ASTM C 840 requirements that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with recommendations of gypsum board manufacturer or, if none available, with United States Gypsum Co.'s "Gypsum Construction Handbook."

C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement. Comply with details shown on Drawings.

1. Where building structure abuts ceiling perimeter or penetrates ceiling.
2. Where partition framing and wall furring abut structure, except at floor.
    a. Install deflection track top runner to attain lateral support and avoid axial loading.

D. Do not bridge building control and expansion joints with steel framing or furring members. Independently frame both sides of joints with framing or furring members as indicated.

3.3 INSTALLING STEEL FRAMING FOR WALLS AND PARTITIONS

A. Install runners (tracks) at floors, ceilings, and structural walls and columns where gypsum board stud assemblies abut other construction.

1. Where studs are installed directly against exterior walls, install asphalt felt strips or foam gaskets between studs and wall.

B. Installation Tolerances: Install each steel framing and furring member so that fastening surfaces do not vary more than 1/8 inch from the plane formed by the faces of adjacent framing.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

1. Cut studs 1/2 inch short of full height to provide perimeter relief.

D. Install steel studs and furring in sizes and at spacings indicated.

1. Single and Multiple-Layer Construction: Space studs 16 inches o.c., unless otherwise indicated.

E. Install steel studs so flanges point in the same direction and leading edge or end of each gypsum board panel can be attached to open (unsupported) edges of stud flanges first.

F. Frame door openings to comply with GA-219, and with applicable published recommendations of gypsum board manufacturer, unless otherwise indicated. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   1. Install 2 studs at each jamb, unless otherwise indicated.
   2. 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.
   3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.

G. Frame openings other than door openings to comply with details indicated or, if none indicated, as required for door openings. Install framing below sills of openings to match framing required above door heads.

3.4 INSTALLATION OF STEEL FRAMING FOR SUSPENDED AND FURRED CEILINGS

A. Suspend ceiling hangers from building structural members and as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are no part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter splaying or other equally effective means.
   2. Where widths of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the locations of hangers at spacings required to support standard suspensions system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads with performance limits established by referenced standards.
   3. Secure hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews or other devices that are secure and appropriate for structure to which hangers are attached as well as for type of hanger involved, and in a manner that will not cause them to deteriorate of fail because of age corrosion and elevate temperatures.
   4. Do not attach hangers to metal roof deck or metal deck tabs.
   5. Do not connect or suspend steel framing from ducts, pipes or conduits.

B. Keep hangers and braces 2 inches clear of ducts, pipes and conduits.

C. Sway-brace suspended steel framing with hangers used for support.

D. Install suspended steel framing components in sizes and at spacings indicated, but not less than that required by referenced steel framing installation standard nor less than the following:
   1. Wire Hangers: 0.1620 inch diameter (8 gage), 4 ft. o.c.
   2. Carrying Studs (Main Runners): 4 ft. o.c.
   3. Rigid Furring Channels (Furring Members): 16 inches o.c.

E. Installation Tolerances: Install steel framing components for suspended ceilings so that cross furring member are level to within 1/8 inch in 12 ft. as measured both lengthwise in each member and transversely between parallel members.

F. Wire-tire or clip furring members to main runners and to other structural supports as indicated.

3.5 APPLYING AND FINISHING GYPSUM BOARD, GENERAL

A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C 840 and GA-216.

B. Fire tape all rated partitions even where exposed to view.

C. Install sounds-attenuation blankets, where indicated, prior to installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

D. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

E. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. 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.

F. Locate both edge or end joints over supports, expect 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. Avoid joints other than control joints at corners of framed openings where possible.

G. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

H. Attach gypsum panels to framing provided at openings and cutouts.

I. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Instead, float gypsum panels over these members using resilient channels or provide control joints to counteract wood shrinkage.

J. Grout hollow metal door frames for both wood and hollow metal doors completely solid.

K. Form control and expansion joints at locations indicated (or at 30’ max. if not indicated) and as detailed, with space between edges of adjoining gypsum panels, as well as supporting framing behind gypsum panels.

L. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), unless otherwise indicated on drawings.

1. Fit gypsum panels around ducts, pipes, and conduits.

M. Isolate perimeter of nonload-bearing gypsum board partitions at structural abutments, except floors, as detailed. Provide 1/4- to 1/2-inch wide spaces at these locations and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

N. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.
   1. Space screws a maximum of 8 inches oc along edges and 12” o.c. otherwise.

O. Provide approximate ¼ inch gap at floor to minimize moisture wicking up gypsum surface.

3.6 GYPSUM BOARD APPLICATION METHODS

A. Single-Layer Application: Install gypsum wallboard panels as follows:
   1. On ceilings, apply gypsum panels prior to wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
   2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated, and provide panel lengths that will minimize end joints.
   3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

B. Single-Layer Fastening Methods: Apply gypsum panels to supports as follows:
   1. Fasten with screws.

3.7 INSTALLING TRIM ACCESSORIES

A. General: For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.

B. Install cornerbead at external corners.

C. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.
   1. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
   2. Install L-bead where edge trim can only be installed after gypsum panels are installed.
   3. Install U-bead where indicated.
   4. Install bridge screed at expansion joint locations in gypsum wallboard.
   5. Install aluminum trim and other accessories where indicated.

D. Install control joints according to ASTM C 840 and manufacturer's recommendations and in specific locations approved by Architect for visual effect.

3.8 ACOUSTICAL ACCESSORIES INSTALLATION

A. Place acoustical insulation in partitions tight within spaces, around cut openings, behind and around electrical and mechanical items within or behind partitions, and tight to items passing through partitions. Install above all ceilings and within demising walls. Use wires to secure in place is necessary.

B. Install acoustical sealant within partitions in accordance with manufacturer's instructions.

3.9 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Treat gypsum board joints, interior angles, flanges of cornerbead, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.

B. Prefill open joints, rounded or beveled edges, and damaged areas using setting-type joint compound.

C. Apply joint tape over gypsum board joints, except those with trim accessories having flanges not requiring tape.

D. Apply joint tape over gypsum board joints and to flanges of trim accessories as recommended by trim accessory manufacturer.

E. Finish interior gypsum wallboard by applying joint compounds in three coats (not including prefill of openings in base) and sand between coats and after last coat.

1. Embedding and First Coat.
2. Fill (Second) Coat.
3. Finish (Third) Coat.

3.10 CLEANING AND PROTECTION

A. Promptly remove any residual joint compound from adjacent surfaces.

B. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure gypsum board assemblies are without damage or deterioration at the time of Final Completion.

END OF SECTION 09 2900

SECTION 09 3000
TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Ceramic, Porcelain or stone tile floors, walls, and base finish using a latex-modified thinset application method, with a quartz polymer modified grout and premium waterproofing and crack isolation membrane.

1.3 REFERENCES

A. ANSI/TCA A108.5 - Ceramic Tile Installed with Dry-Set Portland Cement Mortar or Latex Portland Cement Mortar.
B. ANSI/TCA A118.1 - Dry-Set Portland Cement Mortar.
C. ANSI/TCA A118.4 - Latex-Portland Cement Mortar.
D. ANSI/TCA A137.1 - Specifications for Ceramic Tile.
E. ANSI/TCA A118.3 – Specifications for Chemical Resistant, Water Cleanable Tile Setting and Grouting Epoxy and Water Cleanable Tile Setting Adhesive.
F. TCA (Tile Council of America) - Handbook for Ceramic Tile Installation.
G. ASTM C482-81 - Standard Test Method for Bond Strength of Ceramic Tile to Portland Cement Mortar.
H. ASTM C485 - Standard Test Method for Measuring Warpage of Ceramic Tile.
I. ASTM C499- Standard Test Method for Determining Facial Dimensions and Thickness of Flat, Rectangular Wall and Floor Tile.
J. ASTM C501 - Standard Test Method for Measurement for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser.
K. ASTM C609-81 - Standard Test Method for Measurement of Small Color Differences Between Ceramic Wall or Floor Tile.
L. ASTM C48-84 - Standard Test Method for Breaking Strength of Ceramic Tile.
M. ASTM C1027- Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile.
N. ASTM D2047- Standard Test Method for Evaluating the Static Coefficient of Friction

1.4 SUBMITTALS

A. Submit Product Data indicating material specifications, characteristics, and instructions for using adhesives and grouts and grade of tile.
B. Submit samples of each tile and grout color.
C. Submit manufacturer's installation instructions.
D. Submit maintenance data.
   1. Include recommended cleaning and stain removal methods, cleaning materials, polishes, sealers and waxes.

1.5 QUALITY ASSURANCE

A. Conform to ANSI/TCA A137.1.
B. Conform to TCA Handbook for Ceramic Tile Installation and ANSI/TCA A108.5 for thinset using Latex – Portland Cement Mortar.

C. Conform to TCA Handbook for Ceramic Tile Installation and ANSI/TCA A118.3 for epoxy grouting.
D. Conform to ASTM Standards for Ceramic Tile.
E. Single-Source Responsibility for Ceramic Tile: Obtain each type, composition, variety, color and finish of ceramic tile from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
F. Single-Source Responsibility for Setting and Grout Materials: Obtain products of uniform quality from one manufacturer for each setting and grout component.
   1. Products of the same manufacturer must be used for the following:
      a. Self leveling underlayment patching mortar.
      b. Dry - set Portland cement mortar.
      c. Emulsified latex additives for dry – set Portland cement mortar.
      d. Epoxy Grout.
   2. Use antifracture membrane selected by setting and grout materials manufacturer from specified manufacturers for which setting and grout materials manufacturer will assume single responsibility including warranty.
G. Compatibility and Adhesion Testing: Setting and grout materials manufacturer shall conduct testing as required to establish compatibility and adhesive bond of adhesives or setting mortars used for preformed antifracture membrane and for setting materials with ceramic tile and substrates.
H. Setting and Grout Materials Performance Certification: Provide written statement from setting and grout materials manufacturer that he has reviewed the project requirements including drawings, specifications and related requirements, and certifies that his proposed setting and grout materials, and preformed antifracture membranes are suitable for the applications shown, are compatible with and comply with requirements of ceramic tile manufacturers for setting and grout materials, will comply with system performance requirements, and will result in successful in-service performance.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in the manufacture of products specified in this section with minimum five years documented experience.
B. Installer: Company specializing in applying the work of this Section with minimum of five years documented experience and approved by product manufacturers for both tile and setting materials.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site.
B. Store and protect products.
C. Protect adhesives from freezing or overheating in accordance with manufacturer’s instructions.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not install adhesives in a closed, unventilated environment.
B. Maintain 50 degrees F during installation of mortar materials and seven days after.

C. Review status of substrate work including drying, access limitations and similar considerations. Establish approach, materials and procedures proposed for substrate preparation.

D. Review results of testing to determine moisture vapor emission rates and alkalinity condition of substrates.

1. Do not proceed with installation if moisture vapor emission rates and/or alkalinity determined by testing program exceed recommendations of ceramic tile manufacturer, antifracture membrane manufacturer, or setting and grout material manufacturer.

1.9 EXTRA STOCK

A. Deliver stock of maintenance materials to Owner. Furnish maintenance materials from same manufactured lot as materials installed and enclosed in protective packaging with appropriate identifying labels.

1. Furnish not less than 5% for each type, color, pattern and size of tile and base installed, but not partial boxes, and at least one full box.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER'S (TILE)

A. Floor and Wall Tiles

1. Refer to Room Finish Schedule and drawings for products, patterns and locations. Subject to performance requirements contained herein.

2.2 TILE MATERIAL

A. Floor Tile conforming to the following (refer to Drawings for locations of tile-type):

1. Moisture Absorption: 0 to 0.5%, maximum.
2. Coefficient of Friction: .60 minimum for flat areas

B. Base: Match floor tile for moisture absorption. Refer to Room Finish Schedule for surface finish, color, and tile.

1. Provide integral cove with bullnose top edge and prefabricated one-piece internal and external corners for ceramic installation.

C. Walls: ANSI/TCA A137.1, and conforming to the following (refer to Drawings for locations of tile-type):

1. Moisture Absorption: 0 to 0.5%
2. Edge: Cushioned with bullnose where exposed for ceramic installation.

2.3 ACCEPTABLE ADHESIVE AND GROUT MANUFACTURER'S

A. As acceptable to Tile Manufacturer.

1. Laticrete
2. Mapei

2.4 ADHESIVE MORTAR MATERIALS CERAMIC TILE

A. Mortar Materials: Emulsified Latex Modified Portland Cement Mortar per ANSI A118.4.

2.5 GROUT MATERIALS-CERAMIC TILE

A. Color Admixture: As selected by Architect-Engineer; as manufactured by Laticrete or Mapei.

B. Water-Cleanable Mapei Flexcolor CQ Grout: per ANSI A118.3.

2.7 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, Portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

2. 8 ACCESSORIES

A. Tile Floor Edging: Extruded aluminum trim mouldings.
B. Sealers: Penetrating sealer, as recommended by the grout manufacturer.
C. Temporary Protective Tile Coating: As recommended by tile manufacturer to protect tile during construction.
D. Premium Waterproofing and Crack-Isolation Membrane: (Mapei Mapelastic AquaDefense) with Reinforcing Fabric. Provide full coverage of floor and base.
E. Marble Thresholds, refer to room finish schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work, including proper curing of cementitious underlayments and floors.
B. Beginning of installation means installer accepts condition of existing surfaces.

3.2 PREPARATION

A. Protect surrounding work from damage or disfiguration.
B. Vacuum clean existing substrate and damp clean as required.
C. Seal substrate cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances as required, using trowelable underlayment.
D. Apply sealer-conditioner to surfaces as recommended by adhesive and antifracture membrane manufacturer.
E. Provide premium waterproofing and crack-isolation membrane with reinforcing fabric in accordance with manufacturer's instructions over entire area to be tiled.
F. Provide TCA EJ-171 expansion joint assemblies at intervals not to exceed 24 feet, unless otherwise indicated.
G. In areas of "working" structural cracks contact the Architect for location(s) of TCA EJ-171 expansion joint assemblies.

3.3 INSTALLATION - THINSET METHOD

A. Install adhesive, tile, threshold and grout in accordance with manufacturer's instructions and to TCA Handbook for Ceramic Tile Installation Handbook.
B. Lay tile to pattern indicated on Shop Drawings. Request tile pattern from Architect-Engineer where not indicated on Drawings. Do not interrupt tile pattern through openings. Blend tile from separate runs.
C. Cut and fit tile tight to penetrations through tile. Form corners and bases neatly. Align floor, base, and wall joints.
D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout.

E. Sound tile after setting. Replace hollow sounding units.
F. Keep expansion and control joints free of adhesive or grout. Apply sealant to joints per Section 07 9200 and TCA EJ-171. Locate expansion/control joints per drawings or if not indicated at 24 foot intervals, adjacent to columns/ walls and over “working” cracks in slabs.
G. Allow tile to set for a minimum of 48 hours prior to grouting.
H. Grout tile joints.
I. Apply sealant to junction of tile and dissimilar materials and at junction of dissimilar planes.

3.3 CLEANING & SEALING

A. Clean tile surfaces.
B. Seal unglazed tile and all grout joints – even in glazed tile areas.

3.4 PROTECTION

A. Protect finished installation.
B. Do not permit traffic over finished floor surface.

END OF SECTION 09 3000

SECTION 09 5123
ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Ceilings consisting of acoustical panels and exposed suspension systems.

1.3 SUBMITTALS

A. Product Data: For each type of product specified.

B. Samples for Initial Selection: Manufacturer's color charts consisting of actual acoustical panels or sections of acoustical panels, suspension systems, and moldings showing the full range of colors, textures, and patterns available for each type of ceiling assembly indicated.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed acoustical panel ceilings similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Source Limitations for Ceiling Units: Obtain each acoustical ceiling panel from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

C. Source Limitations for Suspension System: Obtain each suspension system from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

D. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:

1. Surface-burning characteristics of acoustical panels comply with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84.
2. Products are identified with appropriate markings of applicable testing and inspecting agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels and suspension system components to Project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, 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.

1.6 PROJECT 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.

1.7 COORDINATION

A. Coordinate layout and installation of acoustical panels 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.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Acoustical Ceiling Units: Four full boxes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS-ACOUSTICAL PANELS

A. Products: Subject to compliance with requirements, including aesthetic, provide products from one of the following manufacturers:
   1. USG.
   2. Armstrong.

   Refer to drawings for tile design standards.

2.2 ACOUSTICAL PANELS, GENERAL

A. Antimicrobial Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial solution consisting of a synergistic blend of substituted ammonium salts of alkylated phosphoric acids admixed with free alkylated phosphoric acid that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria.

B. Panel Characteristics: Comply with requirements indicated in the Acoustical Panel Ceiling Legend on the Room Finish Schedule, including those referencing ASTM E 1264 classifications.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension System Characteristics: Subject to compliance with requirements, compatibility with ceiling tile, provide products from one of the manufacturers indicated:
   1. USG.
   2. Armstrong.
   3. Refer to drawings for additional information.

B. 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, Table 1, Direct Hung) will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.

C. Hanger Rods: Mild steel, zinc coated.

D. Flat Hangers: Mild steel, zinc coated.

E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch- thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- diameter bolts.

F. Provide heavier gauge trim at locations with radiant ceiling panels to resist warping due to temperature.

G. Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material and finish as that used for exposed flanges of suspension system runners.

1. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Comply with paint manufacturer's written instructions for applying and baking and for minimum dry film thickness.

a. Organic Coating: Manufacturer's standard thermosetting coating system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).

b. Color: As selected by Architect from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and 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 other conditions affecting performance of acoustical panel ceilings.

1. 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 publications referenced below per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
   1. Standard for Ceiling Suspension System Installations: Comply with ASTM C 636.
   2. U.B.C.'s "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings": U.B.C. Standard 25-2.

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. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
   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; that are appropriate for substrate; and that will 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 type of hanger involved. Install hangers in a manner that will 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 cast-in-place hanger inserts, powder-actuated fasteners, or drilled-in anchors that extend through forms into concrete.
   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; and provide hangers not more than 8 inches from ends of each member.

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

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 fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
   1. Where not possible to have full acoustical panel module, field cut edges to provide same appearance as factory reveal edge. Field apply matching paint to cut edges. Resulting appearance must be acceptable to Architect.
   2. Arrange directionally patterned acoustical panels as follows:
      a. Install panels with pattern running in one direction parallel to long axis of space.

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 09 5123

SECTION 09 5426
WOOD PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. Division 09 – Acoustical Tile Ceilings.

1.3 SUMMARY

A. This Section includes wood veneer ceiling panels.

1.4 SUBMITTALS

A. Product Data: For each type of product specified.

B. Samples for Initial Selection: Manufacturer's color charts consisting of actual acoustical panels or sections of acoustical panels, showing the full range of colors, textures, and patterns available for each type of ceiling assembly indicated.

C. Manufacturer's installation instructions.

D. 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.

E. Product Test Reports: Indicate compliance of acoustical panel ceilings and components with requirements based on comprehensive testing of current products.

F. Research/Evaluation Reports: Evidence of acoustical panel ceiling's and components' compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed acoustical panel ceilings similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Source Limitations for Ceiling Units: Obtain each wood ceiling panel from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

C. Source Limitations for Suspension System: Obtain each suspension system from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

D. Fire-Test-Response Characteristics: Provide wood panel ceilings that comply with the following requirements:

1. Surface-burning characteristics of acoustical panels comply with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84.

2. Products are identified with appropriate markings of applicable testing and inspecting agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood panels and suspension system components to Project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

B. Before installing panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle panels carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install 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.

1.8 COORDINATION

A. Coordinate layout and installation of wood panels 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.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Ceiling Tile: Full-size units equal to 5.0 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Design Standard: Armstrong World Industries, Inc., Woodworks Linear Solid Wood Panel System.

2.2 WOOD PANELS, GENERAL

A. Woodworks unperforated solid wood ceiling panels.

B. Solid Poplar hardwood slats and backers.

C. Panel Width 3 ¼" x length as noted on the drawings.

D. Class A fire rated. ASTM E84 surface burning characteristics. Flame Spread index 200 por less. Smoke developed 450 or less.

E. Finish: Refer to room finish schedule.

2.3 SUSPENSION SYSTEM

A. Armstrong Prelude XL. Refer to Room Finish Schedule.

2.4 ACCESSORIES:

A. Cutouts and apertures for lights, fire protection and mechanical systems.
B. Solid wood edge banding for dropped cloud panels.
C. Backer clips.
D. Bio-Acoustic infill panels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and structural framing to which 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 other conditions affecting performance of acoustical panel ceilings.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of 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.

3.3 INSTALLATION

A. General: Install all panels and suspension systems in strict accordance with manufacturer's printed instructions, shop drawings, recommendations and in compliance with Authorities Having Jurisdiction.

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. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
   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; that are appropriate for substrate; and that

will 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 type of hanger involved. Install hangers in a manner that will 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 cast-in-place hanger inserts, powder-actuated fasteners, or drilled-in anchors that extend through forms into concrete.
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; and provide hangers not more than 8 inches from ends of each member.

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

D. Install edge moldings and trim at perimeter of wood ceiling area and where necessary to conceal edges of wood panels.

E. Install wood panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. Where not possible to have full wood panel module, field cut edges to provide same appearance as factory reveal edge. Field apply matching finish to cut edges. Resulting appearance must be acceptable to Architect.
2. Arrange directionally patterned wood panels as follows:
   a. Install panels with pattern running in one direction parallel to long axis of space.

3.4 CLEANING

A. Clean exposed surfaces of wood 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 09 5123

SECTION 09 6519
RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Rubber floor tile.
B. Rubber base.
C. Rubber transition strips.
D. Rubber treads and risers.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Show details of special patterns.
B. Samples for Initial Selection: For each type of floor tile indicated.
C. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation indicated.
   1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.
B. 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.

1.5 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.

1.6 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 Final 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.

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. Floor Tile: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.
   2. Resilient Base: Furnish not less than 10 lineal feet for each 500 linear feet or fraction thereof of each different type and color of resilient wall base installed.

PART 2 - PRODUCTS

2.1 RUBBER FLOOR TILE

A. Products: Subject to compliance with requirements, design basis is Nora Valua, Satura and LVT as indicated on Room Finish Schedule
B. Tile Standard: ASTM F 1066 Class 2, through-pattern tile.
C. Wearing Surface: Refer to room finish schedule.
D. Thickness: 3.5 mm.
E. Size: Refer to room finish schedule.
F. Colors and Patterns: Refer to Room Finish Schedule and Floor Finish Plans.

2.2 RESILIENT BASE AND ACCESSORIES

A. Rubber Wall Base:
   1. Height: 4 Inches.
   2. Thickness: 0.080 inch gage.
   3. Style: Standard topset cove at resilient tile and straight at carpet.
   4. Acceptable Manufacturer's; Armstrong; Johnsonite, Nora.
   5. Color: Refer to Room Finish Schedule.
B. Rubber Edge and Reducer Strips: At all transitions between carpet or rubber tile and dissimilar floor finishes, homogenous vinyl composition, profiles as scheduled, or if not indicated use profiles as recommended by the manufacturer.
   1. Color: To be selected from manufacturer's full range.
   2. Acceptable Manufacturer's: Armstrong; Johnsonite.

2.3 RESILIENT TREADS AND RISERS

A. One-Piece Nosing, Tread, and Riser:
   1. Product Name: Nora Satura stairtreads, Articles 479 (4 foot),

2. ASTM Specification: ASTM F2169 Standard Specification for Resilient Stair Treads, defined as Type TS, Class 2, can be Group 1 and/or 2 and Grade 2
3. Limited Wear Warranty: 10 years.
4. Material: nora vulcanized rubber compound 926 with environmentally compatible color pigments that are free of toxic heavy metals like lead, cadmium or mercury.
5. Composition: Homogeneous rubber compound with a random scattered design.
6. Color: 12 standard colors available.
7. Surface: Hammered and Smooth.
8. Back of Tile: Double-sanded smooth.
9. Stairtread Length: less than 4' length is required.
10. Thickness Tolerance: ASTM F386, ± 1/32 inch (± 0.8mm) is required.
11. Depth: ~1.77 (45mm), as specified ± 1/8th inch (3.2mm) is required.
12. Flammability: ASTM E648; NFPA 253; NBSIR 75 950, 1.0 achieved, ≥ 0.45 watts/sq. cm for Class 1 is required.
13. Smoke Density: ASTM E662; NFPA 258; NBS, 334 (flaming) and 168(non-flaming) achieved, < 450 is required.
14. CAN/ULC-S102.2: Surface Burning, FSC1 of 70 and SD of 470 achieved.
15. Burn Resistance: Resistant to cigarette and solder burns
16. Slip Resistance: ASTM D2047 Static coefficient of friction, Neolite dry - 0.99, Neolite wet - 0.95 achieved, ≥ 0.5 is required
17. Bacteria Resistance: ASTM E2180 and ASTM G21, resistant to bacteria, fungi, and micro-organism activity
18. VOC's: This flooring is GREENGUARD Gold Certified for Low VOC Emissions (formerly GREENGUARD Children & Schools), GREENGUARD Certified for Low VOC Emissions (formerly GREENGUARD Indoor Air Quality Certified), Blue Angel Certified and CA 01350 Compliant.
19. Latex Allergies: ASTM D6499, Inhibition Elisa, results are below detection level.
20. Hardness: ASTM D2240, Shore type "A", 82 achieved, ≥ 70 is required.
21. Static Load: ASTM F970, Residual compression of 0.005" with 800 lbs. achieved, ≤ 0.005" with 250 lbs. is required.
22. Abrasion Resistance: ASTM D3389, 500 gram load on H-18 wheel with 1000 cycles, 0.05 grams weight loss achieved, ≤ 1.0 is required.
23. Oil & Grease Resistant: Yes.
24. Heat Resistance: ASTM F1514, Avg. $\Delta E \leq 8.0$ is required, easily achieved with all batches and regular maintenance.
25. Light Resistance: ASTM F1515, Avg. $\Delta E \leq 8.0$, easily achieved with all batches and regular maintenance.
26. Static Generation: AATCC 134, < 2000 Volts at 20% RH, achieved.

27. Cleaning: Follow manufacturer's maintenance instructions available on website at www.nora.com/us.
28. Shine: Higher shine achieved by buffing without any artificial topical applied coatings.
29. Stain Removing: ASTM F925 Suggested Test Reagents plus the common chemicals used in healthcare and education facilities were used. All resulted in no permanent damage to the floor; however, concentrated Nitric Acid, Methylene Blue and Silver Nitrate showed slight discoloration that required the nora pro clean® system to remove.
30. Substrate Preparation: nora pro install® products are recommended as required following the nora® Installation Guide, this may consist of part of, or all of, the following steps depending on project specifics:
    Step 1 – nora® membrane
    Step 2 – nora® primer
    Step 3 – nora® leveler
    Step 4 – nora® patch
    Step 5 – nora® adhesives, the flooring type, usage and substrate conditions will determine the appropriate adhesive. Please contact your nora® representative for specific recommendations.

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 floor tile, base and substrate conditions indicated.
    1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
        a. Tile Adhesives: Not more than 50 g/L.

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.
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 unless otherwise indicated.
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 running in one direction unless otherwise indicated.
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 INSTALLATION OF ACCESSORIES

A. Apply wall base to walls, columns, pilasters, casework and other permenant fixtures in rooms or areas where base is required. Install base in lengths as long as practicable. Provide premolded inside and outside corners. Tightly bond base to substrate throughout length of each piece, with continuous contact at horizontal and vertical surfaces.
   1. On masonry surfaces or other similar irregular vertical substrates, fill voids between top edge and vertical surface with manufacturer's recommended adhesive filler material, color to match base.

B. Place resilient edge strips tightly butted to flooring and secure with adhesive. Install edging strips at edges of flooring which would otherwise be exposed.

3.5 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 coats per tile tile manufacturer's recommendations..

E. Protect floor tile until Final Completion.

END OF SECTION 09 6519

SECTION 09 6813
TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes modular, fusion-bonded carpet tile and walk-off carpet tile mats.

B. Related Sections include the following:

1. Division 09 Section Resilient Tile Flooring" for resilient wall base and accessories installed with carpet tile.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation recommendations for each type of substrate.

B. 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.

C. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.

E. 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.

F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104, Section 5, "Storage and Handling."

1.6 PROJECT CONDITIONS

A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."

B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

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.

1.7 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which 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 5 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
3. Warranty Period: 10 years from date of Final Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, 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 2 percent of amount installed for each type indicated, but not less than 10 sq. yd. or one full box. Partial boxes are not acceptable.

PART 2 - PRODUCTS

2.1 CARPET TILE/WALK-OFF MAT

A. Design Standards are indicated on the drawings, subject to compliance with requirements.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

1. ARDEX P51 Primer with ARDEX K 15 DR Premium Self-leveling Underlayment.

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. VOC Limits: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).

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. 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 1/16 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 for fully gluing down carpet tiles.
B. Installation Method: As recommended in writing by carpet tile manufacturer.
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, "Protection of 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.

END OF SECTION 09 6813

SECTION 09 7200
WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Textile wall covering.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by 24” long in size.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 WARRANTY

A. Warranty Period: 10 years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings 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: Comply with ASTM E84; 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.
2. Fire-Growth Contribution: No flashover and heat and smoke release according to NFPA 265.

2.2 TEXTILE WALL COVERING

A. Description: Provide mildew-resistant wall coverings in rolls from same production run and that comply with ASTM E84 Class A / Class 1.

B. Total Weight: 12.6 oz/linear yard, excluding coatings.

C. Width: 52 inches.

D. Applied Backing Material: Acrylic.

E. Colors, Textures, and Patterns: As selected by Architect from manufacturer's full range.

2.3 ACCESSORIES

A. Adhesive: Mildew-resistant, non-staining, adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.

B. Primer/Sealer: Mildew resistant, complying with requirements in Section 09 9100 Painting and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.

PART 3 - EXECUTION

3.1 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall covering, 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. Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
3. Metals: If not factory primed, clean and apply primer recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
4. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
5. Painted Surfaces: Treat areas susceptible to pigment bleeding.

D. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.

E. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

F. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.2 WALL-COVERING INSTALLATION

A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.

B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

D. Install wall covering without lifted or curling edges and without visible shrinkage.

E. Match pattern 72 inches above the finish floor.

F. Install seams vertical and plumb at least 6 inches from inside and outside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.

G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.

H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

I. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.

J. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 09 7200

SECTION 09 8413
FIXED SOUND ABSORPTIVE PANELS

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 SECTION INCLUDES

A. Field installed acoustical treatment consisting of fabric stretched over acoustical core material, attached to continuous concealed mounting system.

1.3 QUALITY ASSURANCE

A. Specialty Subcontractor: Fabric wall covering systems shall be furnished and installed by experienced specialty Subcontractors with a proven history of at least five (5) years in the furnishing and installation of fabric wall covering systems of the types required for this project, or by Installation Subcontractors approved in writing by the system manufacturer.

B. Fire Hazard Classification: Provide materials which will meet a Class A fire hazard classification. The combination required for the type of installation shall not support combustion.

1.4 SUBMITTALS

A. Manufacturer's Data: Installer shall submit three copies of manufacturer's specifications, recommendations and standard details for stretched fabric acoustical treatment system including fabrication, installation, and acoustical performance.

B. Shop Drawings and detail drawings, including typical panel conditions, sectional views, joint and connection details, seaming layout, materials, and finishes.

C. Operations and maintenance manuals.

D. Samples: For each fabric type selected, Installer shall submit a mock-up of the fabric wall covering system mounted on a 24" X 24" hardwood backing with wood framing and acoustical core material as specified. These samples shall be approved by the Architect-Engineer and Acoustical Consultant prior to installation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to the project site in original packages or containers clearly labeled to identify manufacturers' brand name, quality or grade, and fire hazard classification.

B. Storage: Store materials in original undamaged packages or containers. Do not store fabric wall covering in an upright position. Maintain temperature in storage to not less than 65 degrees Fahrenheit for at least 24 hours before installation.

C. Handling: Use all means necessary to protect the material before, during, and after installation and to protect the work and materials of other trades.

1.6 SITE CONDITIONS

A. Space Enclosure: Do not install fabric wall covering system until space has been enclosed and is weather tight, and until wet work in the space has been completed and is nominally dry, and until ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

B. The Installer shall examine the conditions under which the work is to be performed and notify the General Contractor or Owner's representative in writing of any conditions detrimental to the proper and timely completion of the work. Work shall not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

C. Installer shall verify all conditions and dimensions that are shown of the drawings in the field and shall notify the Architect-Engineer before any deviations are made from the dimensions or conditions so indicated on the drawings.

D. Substrates shall be adequately sealed and gypsum wall board shall be taped, spackled, and sealed against air or moisture leakage through the wall.

E. Temperature: Maintain a constant minimum temperature of 70 degrees Fahrenheit at areas of installation for at least 48 hours before, during and 48 hours after the application of materials.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS ARE:

1. Carnegie; Xorel Artform; Quiet-Core; Hex.
2. Approved Equal.

2.2 FABRICS

A. To be selected from manufacturers full range.

2.3 CONCELED FABRIC FASTENERS

A. Fastening system shall be completely concealed, and shall allow stretching and straightening of the fabric. The system shall secure fabric on all sides. The fasteners and fabric shall be removable in case of damage and easily replaceable without affecting adjacent surfaces.

2.4 WOOD FRAMING AND BLOCKING

A. All framing and blocking shall be S4S using appearance grade or better of any species used.

B. Wood shall be kiln-dried to a maximum moisture content of 19 percent after treatment.

C. Each piece of lumber shall be inspected after drying. Twisted, warped, bowed, or otherwise damaged or defective pieces shall not be used.

D. All wood framing and blocking shall be treated to meet the fire resistance requirements for this application. Fire-retardant treatment shall not bleed through. Fabrication and milling to shapes shown shall be completed prior to treatment, where possible, to minimize cutting and jointing after treatment. Cut surfaces shall be coated after treatment with two heavy brush coats of the same fire-retardant chemical.

2.5 ACOUSTICAL CORE MATERIAL

A. The cavity created by the wood framing shall be filled with a glass fiber board at thicknesses as shown in the drawings, and at a density of 2.0 to 4.0 lbs. per sq. ft.

B. The acoustical core material shall be flushed to the wood grounds and flushed to the back of the fabric and permanently secured to the wall surface to prevent sagging, stretching, or settling.

C. Acoustical core material shall meet the specified fire resistance requirements.

PART 3 - EXECUTION

3.1 SCHEDULING

A. The following work shall be finished prior to installation of the fabric wall covering system.

1. Architectural woodwork
2. Ceiling grid systems
3. Electrical work
4. Floor and base
5. Windows, doors, and trim
6. Painting of adjacent areas

3.2 PREPARATION

A. Acclimatizing: Remove fabric wall covering material from its packaging and allow to acclimatize to the area of installation 24 hours before application.

3.3 INSTALLATION

A. Wood framing and blocking shall be installed plumb and true with the necessary shimming to align perfectly with adjacent surfaces and shall be in one continuous place with smooth edges. Blocking shall be milled to prevent any visible irregularities.

B. Wood framing and blocking shall be installed as necessary to facilitate the installation by others of outlets boxes, electrical controls, and the like.

C. Wood blocking and fastener systems shall be installed in such a manner to prevent them from sagging or moving out of position after fabric has been stretched over them.

D. Sufficient clearance shall be allowed at adjacent wood blocking and/or fastener systems, to avoid puckering or gaps in the fabric.

E. Fabric panels shall be stitched together in continuous runs to provide a monolithic appearance. Fabric woof and warp yarns shall be stretched

and squared in system so that yarns run uniformly in the horizontal and vertical, and are plumb and level, without distortion, pucker, or ripple.

F. Fabric shall be stretched over and locked into the fastener system to ensure a smooth, firm, and secure fabric surface in all directions, free from wrinkles, and with weave straight and parallel to the perimeter anchors, plumb and aligned horizontally and vertically.

G. Fabric panels shall be secured at their perimeter without the use of any gimp, trim, hand sewing, welts, or batons.

H. Where patterns are selected, fabric shall be thread matched at seams to the greatest extent possible within the manufacturing of the fabric. Match and level fabric patterns and fabric grain.

END OF SECTION 09 8413

SECTION 09 9100
PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes surface preparation and field painting of the following:
   1. Exposed interior items and surfaces.
   2. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint exposed surfaces, even if not noted in the room finish schedule. If the paint color is not specifically mentioned for an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate paint. If the schedules do not indicate adjacent color or finish, the Architect will select from standard colors and finishes available.
   1. Painting includes field painting of exposed conduit, ducts, hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment. Note that painting of color coded mechanical piping shall be by mechanical trades in accordance with Owner's standards.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
   1. Prefinished items include the following factory-finished components:
      a. Architectural woodwork and casework.
      b. Acoustical wall panels.
      c. Metal toilet enclosures.
      d. Metal lockers.
      e. Finished mechanical and electrical equipment.
      f. Light fixtures.
   2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
      a. Furred areas.
      b. Ceiling plenums.
      c. Pipe spaces.
   3. Finished metal surfaces include the following:
      a. Prefinished aluminum.
      b. Stainless steel.
      c. Chromium plate.
      d. Copper.
      e. Bronze and brass.
   4. Operating parts include moving parts of operating equipment and the following:
      a. Valve and damper operators.
      b. Linkages.
      c. Sensing devices.

d. Motor and fan shafts.

5. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections include the following:

1. Division 5 Section "Metal Fabrications" for shop priming ferrous metal.
2. Division 8 Section "Steel Doors and Frames" for shop priming steel doors and frames.
3. Divisions 15 and 16: Paint exposed mechanical and electrical work unless otherwise specified in Divisions 15 and 16, respectively.

1.3 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell refers to low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.
3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
4. Semi-gloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
5. Full gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.4 SUBMITTALS

A. Product Data: For each paint system specified. Include block fillers and primers.

1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
3. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.

1. After color selection, the Architect will furnish color chips for surfaces to be coated.

C. Samples for Verification: Of each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.

1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. Provide a list of materials and applications for each coat of each sample. Label each sample for location and application.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
   1. Product name or title of material.
   2. Product description (generic classification or binder type).
   3. Manufacturer's stock number and date of manufacture.
   4. Contents by volume, for pigment and vehicle constituents.
   5. Thinning instructions.
   6. Application instructions.
   7. Color name and number.
   8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
   1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.7 PROJECT CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 deg F.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 deg F.

C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
   1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.8 EXTRA MATERIALS

A. Furnish 2 final draw downs of each paint color with paint mix data printed on the draw downs for “Record Documents”.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products from one of the following manufacturers:
   1. ICI Dulux (ICI).
   2. Benjamin Moore & Co. (Moore).
   3. PPG Industries, Inc. (PPG).
   4. Sherwin-Williams Co. (S-W).

Sherwin-Williams Co. products are listed below as design standards. Equivalent products from the list of manufacturers are acceptable.

2.2 PRODUCT DESIGN STANDARDS

A. Interior Latex Primer/Sealer: Sherwin-Williams (S-W) Promar 200 Latex Primer
B. Interior Latex Top Coat: S-W Promar 200 Latex
C. Interior Latex Primer for Metal: S-W DTM Acrylic Primer
D. Interior Latex Top Coat for Metal: S-W DTM Acrylic Coating
E. Interior Alkyd Top Coat for Metal: S-W Steel Spec Fast Dry Alkyd
F. Interior Alkyd Metal Primer: S-W Kem Kromik Universal Metal Primer
G. Interior Water Based Dry Fall: S-W Waterborne Acrylic Dry Fall
H. Interior Block Filler: S-W Heavy Duty Block Filler.
I. Interior Concrete Primer: S-W Loxon Concrete and Masonry Primer.
J. Interior Pre-Catalyzed Epoxy: S-W Pro Industrial Pre-catalyzed Water Base Epoxy.

2.3 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
C. VOC Content of Field-Applied 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); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing ship:
    1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
    2. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L..
    3. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
    4. Floor Coatings: VOC not more than 100g/L.
    5. Shellacs, Clear: VOC not more than 730 g/L.
    6. Shellacs, Pigmented: VOC not more than 550 g/L.
    7. Flat Topcoat Paints: VOC content of not more than 50 g/L.
    8. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
    9. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
    10. Floor Coatings: VOC not more than 100 g/L.
    11. Shellacs, Clear: VOC not more than 730 g/L.
    12. Shellacs, Pigmented: VOC not more than 550 g/L.
    13. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
    14. Dry-Fog Coatings: VOC content of not more than 400 g/L.
    15. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.

16. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.

D. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrications or finishing shop:

1. 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.)
2. 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-trichlororethane.
    y. Vinyl chloride.

E. Colors: Provide color selections made by the Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.

1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify the Architect about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
   1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
   1. Provide barrier coats over incompatible primers or remove and reprime.
   2. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
      a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
      b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's written instructions.
      c. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.
   3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
      a. Blast steel surfaces clean as recommended by paint system manufacturer and according to requirements of SSPC-SP 10.
      b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
      c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents

recommended by paint manufacturer, and touch up with the same primer as the shop coat.

4. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
5. Interior Wood Items Scheduled to Receive Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats.

D. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the schedules.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
8. Finish doors on tops, bottoms, and side edges the same as faces. Sand lightly between each succeeding enamel coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer on metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces. Paint colors shall match owner’s standards for identification.

F. Mechanical items to be painted include, but are not limited to, the following:
1. Heat exchangers.
2. Tanks.
3. Ductwork.
4. Insulation.
5. Motors and mechanical equipment.
6. Accessory items.
7. Note that mechanical piping and supports shall be painted by mechanical trades in accord with WCC standards.

G. Electrical items to be painted include, but are not limited to, the following:
1. Conduit and fittings.
2. Switchgear.
3. Panelboards.

H. Block Fillers: Apply block fillers to concrete and masonry units at a rate to ensure complete coverage with pores filled.

I. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be

painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

J. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

K. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
   1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.5 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
   1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINT SCHEDULE

A. Concrete Substrates, Non-traffic Surfaces:
   1. Latex System:
      a. Prime Coat: Interior latex primer/sealer.
      b. Intermediate Coat: Interior latex matching topcoat.
      c. Topcoat: Interior latex semi-gloss.

B. CMU Substrates:
   1. Latex System:
      a. Prime Coat: Interior/exterior latex block filler.
      b. Intermediate Coat: Interior latex matching topcoat.
      c. Topcoat: Interior latex semi-gloss gloss.

C. Steel Substrates (General):
   1. Latex over Alkyd Primer System:
      a. Prime Coat: Alkyd Anti-corrosive Metal Primer.
      b. Intermediate Coat: Interior Latex Matching Top Coat.
      c. Top Coat: Interior Latex Semi-Gloss.

D. Steel Substrates (Hollow Metal Doors and Frames):
   1. Quick Drying Alkyd System:
      a. Prime Coat: Alkyd Metal Primer.
      b. Intermediate Coat: Quick Drying alkyd matching top coat.
      c. Top Coat: Quick Drying Top Coat.

E. Steel Substrates (Exposed Joists/Beams/Deck Structure Above):
   1. Water Based Dry Fall System:
      a. Prime Coat: Alkyd Anti-corrosive Metal Primer.
      b. Top Coat: Latex Dry Fall Flat.

F. Galvanized Metal Substrates:

1. Latex over Waterborne Primer System:
    a. Prime Coat: Water Based Galvanized Metal Primer.
    b. Intermediate Coat: Interior Latex Matching Top Coat.
    c. Topcoat: Latex Interior Semi-gloss.

D. Gypsum Board Substrates:
1. Latex System:
    a. Prime Coat: Interior latex primer/sealer.
    b. Intermediate Coat: Interior latex matching topcoat.
    c. Topcoat: Interior latex eggshell.

E. Wood
1. Transparent System
    a. One coat Stain
    b. One coat Sealer
    c. Two coats Varnish – Satin

F Gypsum Board Substrates – Corridors
1. Epoxy System
    a. Prime Coat – Manufacturer recommended for topcoat.
    b. Pre-catalyzed water based epoxy - Eggshell.
    c. Pre-catalyzed water based epoxy – Eggshell.

D. Wood Base:
1. Latex System:
    a. Prime Coat: Interior latex primer/sealer.
    b. Intermediate Coat: Interior latex matching topcoat.
    c. Topcoat: Interior latex semi-gloss.

3.8 PAINT COLOR SCHEDULE

A. Refer to Room Finish Schedule.

END OF SECTION 09 9100

SECTION 10 1100
VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Fixed Marker Boards.
   2. Tackboards.

1.3 DEFINITIONS

A. Tackboard: Framed or unframed, tackable, visual display board assembly.

B. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, with a perimeter frame; includes chalkboards, and markerboards.

1.4 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. 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.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.

D. Maintenance Data: For visual display surfaces to include in maintenance manuals.

E. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of motor-operated, sliding visual display units required for this Project.

B. Source Limitations: Obtain visual display surfaces from single source from single manufacturer.

C. 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, 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 MARKERBOARD ASSEMBLIES

A. Porcelain-Enamel Markerboards: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch- thick, porcelain-enamel face sheet with low-gloss finish.

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Claridge Products and Equipment, Inc.
   b. Ghent Manufacturing, Inc.
   c. Marsh Industries, Inc.; Visual Products Group.
   d. PolyVision Corporation; a Steelcase company.
2. Particleboard Core1/2 inch thick; with 0.013-inch thick, galvanized-steel sheet backing.

3. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.

2.2 TACKBOARD ASSEMBLIES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Forbo Flooring Systems.
   2. Claridge Products and Equipment, Inc.
   3. Ghent Manufacturing, Inc.
   4. Marsh Industries, Inc.; Visual Products Group.
   5. PolyVision Corporation; a Steelcase company.

B. Natural-Cork Tackboard : 1/4-inch thick, natural cork sheet factory laminated to 1/4-inch thick particleboard backing.

2.3 MARKERBOARD, AND TACKBOARD ACCESSORIES

A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch-thick, extruded aluminum; standard size and shape.
   1. Factory-Applied Trim: Manufacturer's standard.

2.4 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, balanced around center of board
      a. Provide tight butt joints.
   2. 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.

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 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.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

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 roughing-in for electrical power systems to verify actual locations of connections before installation of motor-operated, sliding visual display units.
C. Examine walls and partitions for proper preparation and backing for visual display surfaces.
D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
E. 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.

3.3 INSTALLATION, GENERAL

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings.

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 10 1100

SECTION 10 1200
DISPLAY CASES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General Conditions and Division 1 Specifications Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Illuminated Display Cases
B. Trim, glass sliding doors, and accessories. .

1.3 REFERENCES

A. ANSI/ASTM B221 - Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
B. APA - American Plywood Association.

ASTM A526 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
ASTM B209 - Aluminum-Alloy Sheet and Plate.
ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Submit Shop Drawings and Product Data under provisions of Section 01 3300.
B. Indicate on Shop Drawings, wall elevations, dimensions, and joint locations.
C. Provide Product Data on trim and accessories.
D. Submit manufacturer's installation instructions under provisions of Section 01 3300.

1.5 MAINTENANCE DATA

A. Submit maintenance data under provisions of Section 01 7300.
B. Include maintenance information on regular cleaning, and stain removal.

1.6 WARRANTY

1. Provide five year warranty under provisions of Section 01 7300.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS ARE:

Allen Display Co.
Marsh Industries, Inc.
Polyvision
Tablet and Ticket Co.

2.2 MATERIALS

A. Aluminum Extrusions: ANSI/ASTM B221, 6063-T5 aluminum alloy, tempered.
B. Tackable Material.
1. Outer Facing: Cork, 1/4 inch thick

2. Core: Hardboard 1/4 inch thick
3. Locate at Top, Bottom, Sides, and Back of case.

Aluminum Panels: ASTM B 209, EN 5052 H12 alloy, minimum 0.05 inch thick.
Adhesives: Type recommended by manufacturer; waterproof type.

2.3 ACCESSORIES

A. Sliding Glass Door Lock shall be keyed to Owner's Requirements, with finish to match aluminum frame.
B. Glass Doors: 1/4" tempered plate glass with ground edges. Extruded aluminum "H" section at top and bottom of doors, finish to match frame.
C. Fiber wheels at bottom and rubber guides at top of doors.

2.4 FRAME AND TRIM

A. Frame: Extruded aluminum, flat profile; concealed fasteners; recess mounted.
B. Overall Cabinet Size: Custom: Refer to drawings for sizes.

2.5 SHELVING

A. 1/4 inch tempered glass with polished edges.
B. Channel standards and heavy duty brackets.

2.6 FINISHES

A. Aluminum Frame and Accessories: Clear anodized finish.
B. Tackable Surface: Fabric over cork, color as selected from manufacturer's standard range.

PART 3 - EXECUTION

3.1 INSPECTION

Verify that surfaces and internal wall blocking are ready to receive work, and opening dimensions are as indicated on shop Drawings.
Beginning of installation means acceptance of existing surfaces, substrate construction.

3.2 INSTALLATION

A. Install units in accordance with manufacturer's instructions. Coordinate with Drawings for location.

Establish height as indicated.
Secure units level and plumb and adjacent units in same plane.
Butt tackable panels tight to hairline joint.

3.3 CLEANING

1. Clean tackboard, aluminum extrusions, and glass in accordance with manufacturer's instructions.
2. Provide protective cover as required.
3. Remove protective cover at Date of Final Completion.

END OF SECTION 10 1200

SECTION 10 2113
TOILET COMPARTMENTS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes color-through phenolic units as follows:
   1. Toilet Enclosures: Ceiling hung.
   2. Urinal Screens: Wall hung.

B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for supports that attach ceiling-hung units to overhead structural system.
   2. Division 06 Section "Rough Carpentry" for blocking.
   3. Division 10 "Toilet Accessories" for toilet tissue dispensers, grab bars, and similar accessories.

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.

B. Shop Drawings: 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.

D. Samples for Initial Selection: For each type of unit indicated.

E. Samples for Verification: Of each type of color and finish required for units, prepared on 6-inch- square Samples of same thickness and material indicated for Work.

1.4 QUALITY ASSURANCE

A. Comply with requirements in CID-A-A-60003, "Partitions, Toilets, Complete."

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication and indicate measurements on Shop Drawings.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating toilet compartments without field measurements. Coordinate wall, floor, ceilings, and other contiguous construction to ensure that actual dimensions

correspond to established dimensions.

PART 2- PRODUCTS

2.1 PHENOLIC UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ampco.
   2. Bobrick Washroom Equipment, Inc.
   3. Global Steel Products Corp.

B. Door, Panel and Pilaster Construction: Solid Phenolic color through panel material with eased and polished edges. Provide minimum 3/4 inch thick doors, pilasters and panels.
   1. Color: To be selected by the architect from the manufacturer's full range.

C. Pilaster Shoes and Sleeves: Stainless steel, ASTM A 666, Type 302 or 304, not less than 0.0312 inch specified thickness and 3 inches high, finished to match hardware.

D. Brackets (Fittings):
   1. Full-Height (Continuous) Type: Manufacturer's standard design; aluminum.

2.2 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
   1. Material: Chrome-plated, nonferrous, cast zinc alloy.

B. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.3 FABRICATION

A. Ceiling-Hung Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with threaded rods, lock washers, and leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.

B. Doors: 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 indicated to be accessible to people with disabilities.
   1. Hinges: Manufacturer's standard self-closing type that can be ad justed to hold doors open at any angle up to 90 degrees.
   2. 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 accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.

3. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
4. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
5. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with accessibility requirements of authorities having jurisdiction. Provide units on both sides of doors at compartments indicated to be accessible to people with disabilities.

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. Panels and Walls: 1 inch.

B. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust so bottoms of doors are level with bottoms of pilasters when doors are in closed position.

C. Wall-Hung Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb and to resist lateral impact.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to 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 10 2113

SECTION 10 2213
WIRE MESH PARTITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division One Specifications Sections apply to this Section.

1.2 DESCRIPTION OF WORK:

A. Extent of wire mesh partitions is shown on drawings and by provisions of this Section.

B. Types of wire mesh partition products required include the following:
   1. Standard duty wire mesh partitions extending to height shown with sliding doors

C. Related Work Specified Elsewhere:
   1. Cylinders: Section 087100.

1.3 QUALITY ASSURANCE

A. Manufacturer: Provide wire mesh partitions as complete units produced by a single manufacturer, including necessary mounting accessories, fitting and fastenings.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for materials required.

B. Shop Drawings: Submit shop drawings showing fabrication and installation of wire mesh partitions. Include plans, elevations and large-scale details showing anchorage, accessory items and attachment to adjacent construction. Provide location template drawings for items supported or anchored to permanent construction

C. Samples for Verification Purposes: Submit color chart showing full range of colors available and 12 inch x 12 inch sample of partitions fabricated using specified wire mesh and frame with standard finish applied.

1.5 PROJECT CONDITIONS

A. Field Measurements: Check actual locations for wire mesh products by accurate field measurements before fabrication and show recorded measurements oh Shop Drawings. Coordinate fabrication and delivery schedules with construction progress to avoid delaying the Work.
   1. Where field measurements cannot be made without delaying the work, guarantee location dimensions and proceed with fabricating wire mesh products without field measurements. Coordinate wall, column, floor and ceiling construction to ensure that actual location dimensions correspond to guaranteed dimensions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products of on of the following:
   1. Acorn Wire & Iron Works, Inc.
   2. California Wire Products Corporation.

3. G-S Company (The).
4. Indiana Wire Products, Inc.
5. Jesco Industries, Inc.
6. King Wire Partitions, Inc.
7. Miller Wire Works, Inc.
8. Newark Wire Works, Inc.
9. SpaceGuard Products.
10. Standard Wire & Steel Works.
11. Wire Crafters, Inc.

2.2 MATERIALS:

A. Steel Wire: ASTM A 853.

B. Steel Channels, Angles, Plates and Bars: ASTM A 36.

C. Steel Sheet: ASTM A 568.

D. Cold-Rolled Steel Channels: Formed from steel sheet.

E. Square Steel Tubing: Cold-formed structural steel tubing, ASTM A 500.

2.3 STANDARD DUTY MESH PARTITIONS

A. Mesh: 10 gage (0.135 inch) diameter intercrimping steel wire woven into 1-1/2 inch diamond mesh, securely clichéd to frame members.

B. Frames: Provide cutouts for pipes, ducts, beams, and other items shown or necessary for partition installation. Finish edges of cutouts to provide a neat, protective edge.
   1. Vertical Members: 1-1/4 inch by 5/8 inch cold-rolled steel C-section channels not less than 0.1046 inch thick with ¼ inch bolt holes approximately 18 inches o.c.
   2. Horizontal Members: 1 inch by ½ inch by 1/8 inch cold-rolled steel channels, mortised and tenoned to vertical members.
   3. Horizontal Reinforcing Members: 1 inch by ½ by 1/8 inch cold-rolled steel channel with wire woven through, or two 1 inch by ½ inch steel channels bolted or riveted toe-to-toe through mesh, and secured to vertical members. Provide number of horizontal reinforcing members to suit panel height as recommended by partition manufacturer.

C. Top Capping Bars: 2-1/4 inch by 1 inch cold-rolled steel channels, secured to top framing channel with ¼ inch “U” bolts spaced not more than 28 inches o.c.

D. Line Posts: As required to comply with Code loading, but not less than 3 inches by 4.1 lb. or 3 ½ by 1-1/4 by 0.1265 inch steel channels; with 5 by 18 by ¼ inch steel base plates punched for attachment to floor.

E. Floor Shoes: Cast metal, sized to suit vertical framing and to provide approximately 3 inches clear space between finished floor and bottom horizontal frame members. Furnish units with set screw for leveling adjustment.

2.4 DOORS

A. Swing Doors: Fabricated from same mesh as partitions, with framing fabricated fro 1-1/2 inch by 1/8 inch steel channels or C-channel, banded with 1-1/2 by 1/8 finch flat steel bar cover plates on 4 sides.
   1. Hardware: 1 ½ pair of hinges.
   2. Cylinder Lock; Mortise type with cylinder specified in Section 08 7100 operated by key outside and lever handle inside. Key to Owner's master key system.

2.5 FABRICATION

A. General: Fabricate wire mesh items from components of sizes not less than those indicated or required to comply with Code loading. Use larger-size components as recommended by wire mesh item manufacturer or required to comply with Code loading. Provide bolts, hardware, and accessories as required for complete installation.
   1. Fabricate wire mesh items to be readily disassembled.
   2. Welding: Weld corner joints of framing and grind smooth, leaving no evidence of joint

B. Standard Duty Wire Mesh Partitions: Fabricate wire mesh partitions with cutouts for pipes, ducts, beams and other items indicated. Finish edges of cutouts to provide a neat, protective edge.
   1. Mesh: Securely clinch mesh to framing.
   2. Framing: Fabricate framing with mortise and tenon corner construction.
      a. Provide horizontal stiffeners as indicated or, if not indicated, as required by panel height and as recommended by wire mesh partition manufacturer. Weld horizontal stiffeners to vertical framing.
      b. Fabricate partition and door framing with slotted holes for connecting adjacent panels.
   3. Fabricate wire mesh partitions with 3 inches of clear space between finished floor and bottom horizontal framing.
   4. Doors: Align bottom of door with bottom of adjacent panels.
      a. For doors that do not extend full height of partition, provide transom over door, fabricated from same mesh and framing as partition panels.
   5. Hardware Preparations: Mortise, reinforce, drill, and tap doors and framing as required to install hardware.

2.6 METAL FINISH:

A. General: Comply with NAAMM's "Metal Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Powder Coated Finish: Apply manufacturer's standard baked finish, complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which mesh wire partitions are to be installed. Notify Construction Manager in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installing anchorages. Coordinate delivery of such items to project site.

3.3 INSTALLATION

A. Anchor wire mesh partitions to floor with 3/8 inch diameter, postinstalled expansion anchors through floor shoes located at each post and corner. Adjust wire mesh partition posts in floor shoes to achieve level and plumb installation.

B. Anchor wire partitions to wall at 12 inches o.c. through back corner panel.
   1. For concrete and solid masonry anchorage use drilled-in expansion shields and hanger or lag bolts.
   2. For hollow masonry anchorage use toggle bolts.

C. Secure top capping bars to top framing channels with ¼ inch diameter “U” bolts spaced not more than 28 inches o.c.

D. Provide line posts at locations indicated or, if not indicated, as follows:
   1. On each side of sliding door openings.
   2. For partitions that are more than 12 feet high, located between each panel.

E. Where standard-width wire mesh partition panels do not fill entire length of run, provide adjustable filler panels to fill openings.

F. Install doors complete with door hardware.

G. Weld or bolt metal bases to wire mesh partitions.

H. Bolt accessories to wire mesh partition framing.

3.4 ADJUST AND CLEAN

A. Adjust moving components for smooth operation without binding.

B. Touch-up damaged finish after completion of installation using field-applied paint to match color of shop applied finish.

END OF SECTION 10 2213

SECTION 10 2226
ACCORDION FOLDING 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. This Section includes the following:
   1. Furnish and install accordion folding partitions as indicated in drawings.

B. Related Sections include the following:
   1. Division 06 for wood framing and supports, and all blocking at head and jambs as required.
   2. Division 09 for wall and ceiling framing at head and jambs.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified in writing by the partition manufacturer, as qualified to install the manufacturer's partition systems for work similar in material, design, and extent to that indicated for this Project.

B. Preparation of the opening shall conform to the dimensions specified, plumb, level, and in accordance to building practices.

C. Acoustical Performance: Test partitions in an independent acoustical laboratory in accordance with ASTM E90 to attain no less than the STC rating specified. Provide a complete and unedited written test report by the testing laboratory upon request.

1.4 SUBMITTALS

A. Product Data: Material descriptions, construction details, finishes, installation details, and operating instructions for each type of partition, component, and accessory specified.

B. Shop Drawings: Show location and extent of partitions. Include plans, elevations, sections, details, attachments to other construction, and accessories. Indicate dimensions, weights, conditions at openings, and at storage areas, and required installation, storage, and operating clearances. Indicate location and installation requirements for hardware and track, including floor tolerances required and direction of travel. Indicate blocking to be provided by others.

C. Setting Drawings: Show imbedded items and cutouts required in other work, including support beam punching template.

D. Samples: Color samples demonstrating full range of finishes available by architect. Verification samples will be available in same thickness and material indicated for the work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Clearly mark packages and partitions with numbering systems used on Shop Drawings. Do not use permanent markings on partitions.
B. Protect partitions during delivery, storage, and handling to comply with manufacturer's direction and as required to prevent damage.

1.6 WARRANTY

A. Warranty shall include all parts, labor, hoisting, rigging, travel time and expenses.
B. Provide written warranty by manufacturer of partitions agreeing to repair or replace any components with manufacturing defects.
C. Warranty period: Two (2) years.

PART 2 – PRODUCTS

2.1 MANUFACTURERS, PRODUCTS, AND OPERATION

A. Manufacturers: Subject to compliance with requirements, provide product by the following:
   1. Modernfold, Inc.
   2. Hufcor.
   3. Approved Equal.
B. Products: Subject to compliance with the requirements, provide the following product:
   1. Basis of Design: Modernfold - Soundmaster #SM12 Accordion Folding Partition.

2.2 OPERATION

A. Manually operated, top supported, accordion folding.

2.3 CONSTRUCTION

A. Shall consist of steel hinge plates welded to 3/16-inch (5mm) diameter vertical steel rods, with a single row of plates at the bottom and top with intermediate rows at approximately 42-inch (1067mm) on center. Partitions 10'-0" (3048mm) high or over have a double row of hinge plates at the top. A high tensile alloy steel trolley yoke, functioning as a hinge pin at required intervals, supports the frame assembly.
B. Sound Transmission Class: Laboratory acoustical performance of the folding partition shall have been tested in an independent acoustical laboratory, in accordance with ASTM E90 test procedure, and shall have attained an STC rating of no less than:
   1. 40 STC

2.4 PARTITION FINISHES

A. Finish: Face finish shall be upholstery fabric with surface treatment to resist stains.
B. Partition Trim: Exposed sweep strips of one consistent color.

2.5 SOUND SEALS

A. Shall be pairs of three-layer flexible sweep strips at top and bottom. Vertical female sound channel shall be polyurethane foam lined.
B. Sound Insulation: 24-gage, V-grooved steel panels and heavy duty flame resistant acoustical membrane. Each panel attaches to the frame with steel leaf fasteners.
C. Pairs of Flexible Sweep Strips: Shall be provided at top and bottom of the partition. Air release for air trapped within the folding partition shall be accomplished during operation by a series of 3/8-inch (9.5mm) diameter holes through the lead post molding.

2.6 HARDWARE

A. Grip type hand pulls shall be die cast zinc, satin chrome finish. Extruded aluminum or plastic hand pulls will not be accepted.

2.7 SUSPENSION SYSTEM

A. #6 or #7 Suspension System, track and trolley sizes matched to the size of the partition.
   1. Suspension Tracks: Shall be of a continuous “C” channel shaped track, connected to the structural support.
   2. Carriers: The accordion folding partition shall be suspended from the track by two-wheel intermediate and four-wheel lead trolley assemblies.

2.8 OPTIONS

A. Jamb-Lock: Back post to be secured to the wall by the “Jamb-Lock” mechanism concealed within the back post to provide a quick means of releasing and reattaching the partition for cleaning and decorative purposes.
B. Locks: Satin chrome hand pulls with master-keyed locks. Master-keyed cylinders furnished by others. Locks shall be an integral part of the pull.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General: Comply with partition manufacturer’s written installation instructions, Drawings, and approved Shop Drawings.
B. Install partitions and accessories after other finishing operations, including painting have been completed.
C. Defective partitions are not acceptable.

3.2 CLEANING AND PROTECTION

A. Clean partition surfaces upon completing installation of partitions to remove dust, dirt, adhesives, and other foreign materials according to manufacturer’s written instructions.
B. Provide final protection and maintain conditions in a manner acceptable to the manufacturer and installer that insure operable partitions are without damage or deterioration at time of Substantial Completion.

3.3 ADJUSTING

A. Adjust partitions to operate smoothly, easily, and quietly throughout entire operational range. Lubricate hardware and other moving parts.

3.4 EXAMINATION

A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of partitions. Proceed with installation only after unsatisfactory conditions have been corrected.

3.5 DEMONSTRATION

A. Demonstrate proper operation and maintenance procedures to Owner's representative.

B. Provide Operation and Maintenance Manual to Owner's representative.

END OF SECTION 10 2226

SECTION 10 2623
WALL AND DOOR PROTECTION

Part 1 – GENERAL

1.01 SUMMARY

A. This section includes the following types of wall protection systems:
   1. Corner Guards.
   2. Stainless Steel Wall Protection.
B. Related sections: The following sections contain requirements related to this section:
   1. Blocking in walls for fasteners; refer to section 061000 Rough Carpentry.

1.02 REFERENCES

A. National codes (IBC, UBC, SBCCI, BOCA and Life Safety)
B. American Society for Testing and Materials (ASTM)
C. Underwriters Laboratories (UL)

1.03 SUBMITTALS

A. General: Submit the following in accordance with conditions of contract and Division 1 specification section 01 3300 “Submittal Procedures”.
B. Product data and detailed specifications for each system component and installation accessory required, including installation methods for each type of substrate.
C. Shop drawings showing locations, extent and installation details of crash rails and corner guards. Show methods of attachment to adjoining construction.
D. Samples for verification purposes: Submit the following samples, as proposed for this work, for verification of color, texture, pattern and end cap attachment and alignment.
   1. 12" (304.8mm) long sample of each model specified
E. Product test reports from a qualified independent testing laboratory showing compliance of each component with requirements indicated.
F. Maintenance data for wall protection system components for inclusion in the operating and maintenance manuals specified in Division 1.

1.04 QUALITY ASSURANCE

A. Installer qualifications: Engage an installer who has no less than 3 years experience in installation of systems similar in complexity to those required for this project.
B. Manufacturer’s qualifications: Not less than 5 years experience in the production of specified products and a record of successful in-service performance.
C. Code compliance: Assemblies should conform to all applicable codes including IBC, UBC, SBCCI, BOCA, Life Safety and CA 01350.
D. Fire performance characteristics: Provide engineered PETG wall protection system components with UL label indicating that they are identical to those tested in accordance with ASTM E84 for Class 1 characteristics listed below:
   1. Flame spread: 25 or less
   2. Smoke developed: 450 or less
E. Impact Strength: Provide assembled wall protection units that have been tested in accordance with the applicable provisions of ASTM F476.
F. Chemical and stain resistance: Provide wall protection system components with chemical and stain resistance in accordance with ASTM D543.

G. Color match: Provide wall protection components that are color matched in accordance with the following:
    1. Delta Ecmc of no greater than 1.0 using CIELab color space. (Specifier note: Construction Specialties' colors are matched under cool white fluorescent lighting and computer controlled within manufacturing tolerances. Color may vary if alternate lighting sources are present).
H. Single source responsibility: Provide all components of the wall protection system manufactured by the same company to ensure compatibility of color, texture and physical properties.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the project site in unopened original factory packaging clearly labeled to show manufacturer.
B. Store materials in original, undamaged packaging in a cool, dry place out of direct sunlight and exposure to the elements. A minimum room temperature of 40°F (4°C) and a maximum of 100°F (38°C) should be maintained.
C. Material must be stored flat.

1.06 PROJECT CONDITIONS

A. Materials must be acclimated in an environment of 65°-75°F (18°-24°C) for at least 24 hours prior to beginning the installation.
B. Installation areas must be enclosed and weatherproofed before installation commences.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Interior surface protection products specified herein and installed on the submittal drawings shall be manufactured by Construction Specialties, Inc.

2.02 MATERIALS

A. Engineered PETG: Extruded material should be high impact Acrovyn 4000 with suede texture. Chemical and stain resistance should be per ASTM D543 standards as established by the manufacturer. Colors to be indicated in the finish schedule from one of manufacturer’s standard color range.
B. Stainless steel: To be type 304 alloy with #4 satin finish.
C. All necessary fasteners to be supplied by the manufacturer.

2.03 CRASH RAILS

A. Engineered PETG Crash Rail to be Acrovyn 4000 Rub Strip by Construction Specialties: Extrusion shall be secured to wall with self-adhesive tape standard (or optional construction adhesive application).
    1. Acrovyn 4000 rubstrips supplied to specified heights cut from .060" (1.52mm) sheet with tapered upper and lower edges.
    2. Color Selection: As selected from manufacturers standard range.

2.04 CORNER GUARDS

A. Stainless Steel Corner Guards to be by Construction Specialties: Surface mounted guards to be 16 gauge stainless steel, continuous full height.
    1. Model CO-8 90° stainless steel corner guard with 3-½" (88.9mm) standard legs. Mounted with construction adhesive.

2.05 FABRICATION

A. General: Fabricate wall protection systems to comply with requirements indicated for design, dimensions, detail, finish and member sizes.
B. Preassemble components in shop as much as possible to minimize field assembly.

2.06 Finishes

A. General: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applications and designations of finishes.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
    1. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface preparation: Prior to installation, clean substrate to remove dirt, debris and loose particles. Perform additional preparation procedures as required by manufacturer's instructions.
B. Protection: Take all necessary steps to prevent damage to material during installation as required in manufacturer’s installation instructions.

3.03 INSTALLATION

A. Install the work of this section in strict accordance with the manufacturer's recommendations, using only approved mounting hardware, and locating all components firmly into position, level and plumb.
B. Temperature at the time of installation must be between 65°-75°F (18°-24°C) and be maintained for at least 48 hours after the installation.

3.04 CLEANING

A. General: Immediately upon completion of installation, clean material and accessories in accordance with manufacturer’s recommended cleaning method.
B. Remove surplus materials, rubbish and debris resulting from installation as work progresses and upon completion of work.

3.05 PROTECTION

A. Protect installed materials to prevent damage by other trades. Use materials that may be easily removed without leaving residue or permanent stains.

END OF SECTION 10 2600

SECTION 10 2800
TOILET ACCESSORIES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Toilet accessories.
B. Attachment hardware.

1.3 RELATED SECTIONS

A. Section 10 2113 Toilet Compartments.

1.4 REFERENCES

A. ANSI A117.1 – Specifications for Making Buildings and Facilities Accessible To and Useable by Physically Handicapped People.
B. ANSI/ASTM A123 – Zinc (Hot-Dip Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strips.
C. ANSI/ASTM A366 – Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.
D. ANSI/ASTM A386 – Zinc Coating (Hot-Dip) on Assembled Steel Products.
E. ANSI/ASTM B456 – Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
F. ASTM A167 – Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
G. ASTM A269 – Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
H. NEMA LD-3 – High Pressure Decorative Laminates.
I. ADA – American with Disabilities Act.
J. ANSI A117.1 – Specifications for Making Buildings and Facilities Accessible to and Usable by Physical Handicapped People.

1.5 SUBMITTALS

A. Provide Product Data on accessories describing size, finish, details of function, attachment methods.
B. Submit manufacturer's installation instructions.

1.6 KEYING

A. Supply two keys for each accessory to Owner.
B. Master key all accessories.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for installing work in conformance with ANSI A117.1.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate the work of this Section with the placement of internal wall reinforcement and reinforcement of toilet partitions to receive anchor attachments.

PART 2 – PRODUCTS

2.1 OWNER'S DESIGN STANDARD IS BRADLEY, UNLESS NOTED OTHERWISE.

A. Paper towel dispensers are owner provided, contractor installed.
B. Soap dispensers are owner provided, contractor installed.
C. Toilet tissue dispensers are owner provided, contractor installed.
D. Grab bars are contractor provided, contractor installed.
E. Sanitary napkin disposal units are contractor provided, contractor installed.
F. Stainless steel framed mirrors are contractor provided, contractor installed.

2.2 MATERIALS (TOILET ACCESSORIES)

A. Stainless Steel Sheet: ASTM A167, Type 304.
B. Tubing: ASTM A269, Stainless Steel.
C. Adhesive: Two component epoxy type, waterproof.
D. Fasteners, Screws, and Bolts: Hot dip galvanized, tamperproof.
E. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.3 FABRICATION (TOILET ACCESSORIES)

A. Weld and grind smooth joints of fabricated components.
B. Form exposed surfaces from single sheet of stock, free of joints.
C. Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.
D. Back paint components where contact is made with building finishes to prevent electrolysis.
E. Shop assemble components and package complete with anchors and fittings.
F. Provide steel anchor plates, adapters, and anchor components for installation.
G. Hot dip galvanize exposed and painted ferrous metal and fastening devices.

2.4 FACTORY FINISHING (TOILET ACCESSORIES)

A. Stainless Steel: No. 4 satin luster finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that site conditions are ready to receive work and dimensions are indicated on Shop Drawings, and as instructed by the manufacturer.
B. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

A. Deliver inserts and rough-in frames to site at appropriate time for building-in.
B. Provide templates and rough-in measurements as required.
C. Verify exact location of accessories for installation.

3.3 INSTALLATION

A. Install fixtures, accessories and items in accordance with manufacturer's instructions.
B. Install plumb and level, securely and rigidly anchored to substrate.
C. Owner will furnish paper towel dispensers and soap dispensers for installation by contractor. All other accessories will be furnished and installed by contractor.

3.4 SCHEDULE

A. Refer to drawings for Toilet Accessory Schedule.

END OF SECTION 10 2800

SECTION 10 4413
FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Fire-extinguisher cabinets:
   2. Fire-extinguishers provided by owner.
   3. Fire Extinguisher Cabinet Signage.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection specialties.
   1. Fire Extinguishers: Include rating and classification.
   2. 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.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fire extinguishers and cabinets through one source from a single manufacturer.

B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Standard for Portable Fire Extinguishers."

C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   1. Provide extinguishers listed and labeled by FM.

1.5 COORDINATION

A. Coordinate size of cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Fire-Protection Cabinets:
      a. J.L. Industries, Inc.
      b. Larsen's Manufacturing Company.
      c. Potter-Roemer; Div. of Smith Industries, Inc.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: Carbon steel, complying with ASTM A 366/A 366M, commercial quality, stretcher leveled, temper rolled.

2.3 FIRE-PROTECTION CABINETS

A. Cabinet Construction: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld joints and grind smooth. Miter and weld perimeter door frames.
   1. Cabinet Metal: Enameled-steel sheet.

B. Cabinet Type: Suitable for the following:
   1. Fire extinguisher.

C. Cabinet Mounting: Suitable for the following mounting conditions:
   1. Surface: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.

D. Cabinet Trim Style: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth. Semi-recessed with 2 1/2 inch return.

E. Cabinet Trim Material: Manufacturer's standard, as follows:
   1. Same metal and finish as door.

F. Door Material: Manufacturer's standard, as follows:
   1. Satin Stainless Steel.

G. Door Style: Manufacturer's standard design, as follows:
   1. Vertical duo panel with frame.

H. Door Construction: Fabricate doors according to manufacturer's standards, of materials indicated, and coordinated with cabinet types and trim styles selected.

I. Door Hardware: Provide manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated. Provide either lever handle with cam-action latch, or exposed door pull and friction latch. Provide concealed or continuous-type hinge permitting door to open 180 degrees.

2.4 ACCESSORIES

A. Mounting Brackets: Manufacturer's standard steel, designed to secure extinguisher, of sizes required for types and capacities of extinguishers indicated, with plated or baked-enamel finish.
   1. Provide brackets for extinguishers not located in cabinets.

B. Identification: Provide lettering to comply with authorities having jurisdiction for letter style, color, size, spacing, and location. Locate as indicated by Architect.
   1. Identify fire extinguisher in cabinet with the words "FIRE EXTINGUISHER" applied to door.
      a. Application Process: Vinyl letters.
      b. Lettering Color: Black.
      c. Orientation: Vertical.

2. Wall mounted fire extinguisher identification marker located above the fire extinguisher.

C. Signage: Provide signage above existing fire extinguisher cabinet locations similar to JL Industries, Plastic Sign, 5" x 6", 3D tent, FE #24S.

2.5 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitability where cabinets are to be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing fire-protection specialties.

B. Install in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

1. Fasten mounting brackets to structure and cabinets, square and plumb.
2. Fasten cabinets to structure, square and plumb.

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust cabinet doors that do not swing or operate freely.

B. Refinish or replace cabinets and doors damaged during installation.

C. Provide final protection and maintain conditions that ensure that cabinets and doors are without damage or deterioration at the time of Final Completion.

END OF SECTION 10 4413

SECTION 11 5700
VOCATIONAL SHOP EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes welding booths, suitable for both gas and arc welding.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
C. Samples of factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS
A. Welding certificates.
B. Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance data.

1.6 QUALITY ASSURANCE
A. 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."
B. Regulatory Requirements: Comply with requirements of Authority Having Jurisdiction.
C. Preinstallation Conference: Conduct conference at Project site.

1.7 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair finish or replace wall panels 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 MATERIALS

A. Steel Structural Tubing: ASTM A 500, Grade B.
B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
C. Anchorages: As recommended by Booth Manufacturer.

2.2 WELDING BOOTHS, GENERAL

A. General: Provide a complete, integrated set of mutually dependent components that form a completely assembled, ready for installation on Project site.
   1. Welded square tubular steel frame.
   2. Minimum 16 ga. steel panels (partial height).
   3. Adjustable leveling feet.
   4. Fume arm bracket (coordinate with mechanical trades).
   5. Welding Curtain.

2.3 ACCEPTABLE MANUFACTURERS

A. Avani Environmental
B. Lincoln Electric
C. Substitutions per Section 01 6000 and 01 6000a.

2.4 FABRICATION

A. Fabricate booths to greatest extent possible in factory.
B. Refer to drawings for layout and dimensions.

2.5 FINISHES

A. Powder Coat finish in color selected by Architect from manufacturer’s full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install booths according to manufacturer's written instructions.
B. Set booths plumb and aligned. Level, true to plane, bearing on concrete.
C. Adjust hardware to operate smoothly, easily, properly, and without binding.
D. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 11 5700

SECTION 11 6143
STAGE CURTAINS

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes stage curtains for:
   1. Green Screen.
   2. Blackout.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Show fabrication and installation details for stage curtains. Include plans, elevations, sections, details, and attachments to other work.
C. Samples: For each fabric and for each color and texture specified, full width by 36 inches (900 mm) in size, from dye lot to be used for the Work, with specified treatments applied.
D. Delegated-Design Submittal: For rigging indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS
A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS
A. Operation and maintenance data.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: Fabricator of stage curtains.
B. Fire-Test-Response Characteristics: Provide stage curtains with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or a testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Flame-Resistance Ratings: Passes NFPA 701.
      a. Permanently attach label to each fabric of curtain assembly indicating whether fabric is inherently and permanently flame resistant or treated with flame-retardant chemicals, and whether it requires retreatment after designated time period or cleaning.

1.6 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of rigging equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CURTAIN FABRICS

A. General: Provide fabrics inherently and permanently flame resistant or chemically flame resistant by immersion treatment to comply with requirements indicated. Provide fabrics of each type and color from same dye lot.

B. Polyester: 100 percent polyester yarn woven fabric weighing not less than 22 oz./linear yd. (681 g/linear m); inherently and permanently or durably flame resistant; 64-inch (1626-mm) width.

1. Products: Subject to compliance with requirements, provide the following as Basis of Design: Rose Brand; 22oz Encore Velour, IFR.
   a. S&K Theatrical Draperies.
   b. Approved equal by others.
2. Color: Black.

2.2 CURTAIN FABRICATION

A. General: Affix permanent label, stating compliance with requirements of authorities having jurisdiction, in accessible location on curtain not visible to audience. Provide vertical seams unless otherwise indicated. Arrange vertical seams so they do not fall on faces of pleats. Do not use fabric cuts less than one-half width.

1. Vertical Hems: Provide vertical hems not less than 2 inches (50 mm) wide, with not less than a 1-inch (25-mm) tuck, and machine sew with no selvage material visible from front of curtain. Sew open ends of hems closed.
2. Top Hems: Reinforce top hems by double-stitching 3-1/2-inch- (89-mm-) wide, heavy jute webbing to top edge on back side of curtain with not less than 2 inches (50 mm) of face fabric turned under. Provide looped sleeves for stationary curtains to be mounted on existing pipe suspension system.
3. Grommets: Brass, No. 3 or No. 4; 1 inch (25 mm) from corner of curtain; for S-hooks.
4. Bottom Hems: Provide hems not less than 6 inches (150 mm) deep with weight tape.

B. S-Hooks: Manufacturer's standard heavy-duty plated-wire hooks, not less than 2 inches (50 mm) long.

2.3 ALUMINUM-CURTAIN TRACK (REAR TRAVELLER)

A. Aluminum Traveler Track: Fabricate of extruded aluminum; complying with ASTM B 221 (ASTM B 221M); alloy and temper recommended by manufacturer for strength and corrosion resistance 0.125 inch (3.1 mm) thick; mill finish.

1. Products: Subject to compliance with requirements, provide the following as Basis of Design: Automatic Devices Company; Rig-I-Flex 140 series.
   a. Approved equal by others.

B. Curtain Rails: Provide end stops for track rails.

C. Curtain Carriers: Standard carriers with a quantity of curtain carriers sufficient for track length, to suit curtain fabrication. Include one master carrier for each leading curtain edge.

D. Clamp and Bracket Hangers: Manufacturer's steel clamps and brackets of sufficient strength required to support loads for attaching track to overhead support.

E. Track Lap Clamp: Metal to match track channel for attaching double-sectioned track at center overlap.

F. Fold Guide: Equip carriers with rear-fold or backpack guide and rubber spacers to permit offstage curtain folding; sized for use with operating line if any.
G. Walk-Along Manual Operation: Fabricate curtain track without cord, cable, pulleys, or floor block.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Examine areas and conditions, with Installer present, for compliance with requirements for supporting members, blocking, installation tolerances, clearances, and other conditions affecting performance of stage-curtain work. Examine inserts, clips, blocking, or other supports required to be installed by others to support tracks and battens.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Install stage-curtain system according to track manufacturer's and curtain fabricator's written instructions.
D. Pipe-Mounted Tracks: Install tracks by suspending from manufacturer's special bracket clamps securely mounted to wall construction at spacing, according to manufacturer's written instructions.
E. Install track for center-parting curtains with not less than 24-inch (600-mm) overlap of track sections at center, supported by special lap clamps.
F. Track Hung: Secure curtains to track carriers with s-hooks.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain stage curtains and tracks.

END OF SECTION 11 6143

SECTION 12 2413
ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:
   1. Roller shades.
      a. Provide at all exterior windows as noted on the plans, excluding corridors and stairwells.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.

B. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.

C. Samples for Verification:
   1. Complete, full-size operating unit not less than 16 inches wide for each type of roller shade indicated.
   2. For the following products:
      a. Shade Material: Not less than 3 inches square, with specified treatments applied. Mark face of material.

D. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:
   1. Methods for maintaining roller shades and finishes.
   2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
   3. Operating hardware.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Source Limitations: Obtain roller shades through one source from a single manufacturer.

C. Fire-Test-Response Characteristics: Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Flame-Resistance Ratings: Passes NFPA 701.

D. Product Standard: Provide roller shades complying with WCMA A 100.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, 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 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 operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 ROLLER SHADES

A. Acceptable Manufacturer's: Subject to compliance with requirements.
   1. Draper Inc.
   2. Hunter Douglas Contract.
   3. Lutron Shading Solutions.
   4. Open Light.

B. Shade Fabric: Refer to Room Finish Schedule.

C. Rollers: Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets.

D. Direction of Roll: Regular, from back of roller.

E. Mounting Brackets: Galvanized or zinc-plated steel.

F. Pocket-Style Headbox: U-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; with a bottom cover consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing shade roller, brackets, and operating hardware and operators within.
   1. Corner Section: Factory formed and welded.

G. Closure: 2 or 3 inches as required.

H. Bottom Bar: Steel or extruded aluminum, with plastic or metal capped ends. Provide concealed, by pocket of shade material, internal-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.

2.2 ROLLER SHADE FABRICATION

A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

B. Concealed Components: Non-corrodible or corrosion-resistant-coated materials.
   1. Lifting Mechanism: With permanently lubricated moving parts.

C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F.
   1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.

D. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting headbox, roller, and operating hardware and for hardware position and shade mounting method indicated.

E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

F. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

G. Colors of Metal and Plastic Components Exposed to View: As selected by Architect from manufacturer's full range, unless otherwise indicated.

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.
   1. 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, and located so shade band is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

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 roller shades.

END OF SECTION 12 2413

SECTION 20 0500
MECHANICAL GENERAL 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 work of this Section.

1.2 SUMMARY

A. This Section includes mechanical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 01 Specification Sections.

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.
   1. AABC - Associated Air Balance Council; www.aabc.com.
   2. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
   3. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.

4. ABMA - American Boiler Manufacturers Association; www.abma.com.
5. AGA - American Gas Association; www.aga.org.
6. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
7. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
8. ANSI - American National Standards Institute; www.ansi.org.
9. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
10. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
11. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
12. ASTM - ASTM International; www.astm.org.
13. AWS - American Welding Society; www.aws.org.
14. AWWA - American Water Works Association; www.awwa.org.
15. CDA - Copper Development Association; www.copper.org.
16. CGA - Compressed Gas Association; www.cganet.com.
17. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
18. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
19. CSI - Construction Specifications Institute (The); www.csinet.org.
20. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
21. FM Approvals - FM Approvals LLC; www.fmglobal.com.
22. HI - Hydraulic Institute; www.pumps.org.
23. ICC - International Code Council; www.iccsafe.org.
24. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
25. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
26. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
27. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org
28. NADCA - National Air Duct Cleaners Association; www.nadca.com.
29. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
30. NEBB - National Environmental Balancing Bureau; www.nebb.org.
31. NECA - National Electrical Contractors Association; www.necanet.org.
32. NEMA - National Electrical Manufacturers Association; www.nema.org.
33. NETA - InterNational Electrical Testing Association; www.netaworld.org.
34. NFPA - National Fire Protection Association; www.nfpa.org.
35. NSF - NSF International; www.nsf.org.
36. NSPE - National Society of Professional Engineers; www.nspe.org.
37. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
38. STI - Steel Tank Institute; www.steeltank.com.
39. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
40. UL - Underwriters Laboratories Inc.; www.ul.com.
41. USGBC - U.S. Green Building Council; www.usgbc.org.

1.4 PERFORMANCE REQUIREMENTS

A. Systems Components Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

1.5 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the mechanical systems as specified in the Mechanical; Fire Suppression; Plumbing; and Heating, Ventilating, and Air Conditioning Sections and as indicated on Drawings.

B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of ASHRAE, NFPA, SMACNA and UL, unless otherwise indicated.
   1. Notify the Architect/Engineer in writing before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations.
   2. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to A/E, the Contractor shall bear all costs arising from corrective measures.
   3. No contract sum adjustments or contract time extensions will be made for Contractor claims arising from conditions which were or could have been observable, ascertainable or reasonable foreseeable from a site visit or inquiry into local conditions affecting the execution of the work.

C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.

D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

F. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner's Representatives causes interference.

G. Labeling Requirement for Packaged Equipment: Electrical panels on packaged mechanical equipment shall bear UL label or label of other Nationally Recognized Testing Laboratory (NRTL) (ITSNA, CSA, etc.).

1.6 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for Mechanical Work shall be secured and paid for by the Contractor. All Work shall conform to all applicable codes, rules and regulations.

B. Rules of local utility companies shall be complied with. Check with each utility company supplying service to the installation and determine all devices including, but not limited to, all valves, meter boxes, and meters which will be required and include the cost of all such items in proposal.

C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed drawings or diagrams which may be required by the governing authorities. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.

1.7 DRAWINGS

A. The drawings show the location and general arrangement of equipment, piping and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, valves and accessories as may be required to meet such conditions.

C. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.
D. The Architectural and Structural Drawings take precedence in all matters pertaining to the building structure, Mechanical Drawings in all matters pertaining to Mechanical Trades and Electrical Drawings in all matters pertaining to Electrical Trades. Where there are conflicts or differences between the drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.
E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.8 MATERIAL AND EQUIPMENT MANUFACTURERS

A. Equipment: All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment and shall be the manufacturer's latest design.
B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, piping, sheet metal, electrical work, and building alterations shall be included in the original Bid. Similar equipment shall be by one manufacturer.
C. All package unit equipment and skid mounted mechanical components that are factory assembled shall meet, in detail, the products named and specified within each section of the Mechanical and Electrical Specifications.
D. Changes Involving Electrical Work: The design of the mechanical systems is based on the equipment scheduled on the Drawings. 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 with no additional cost to project. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
    1. Where equipment changes are made that involve additional Electrical Work (larger size motor, additional wiring of equipment, etc.) the Mechanical Trades involved shall compensate the Electrical Trades for the cost of the additional Work required.

1.9 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.10 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to,

model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, piping, sheet metal, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid, but will not affect the awarding of the contract.

1.11 SUBMITTALS

A. Submit project specific submittals for review in compliance with Division 1.
B. Prepare shop drawings to scale for the Architect/Engineer for review. Equipment and material submittals required are indicated in the Mechanical; Fire Suppression; Plumbing; and Heating, Ventilating and Air Conditioning Sections. Refer to Division 1 for submittal quantities.
C. All submittals shall be submitted in groupings of similar and/or related items. Plumbing fixture submittals shall be submitted as one package including all fixtures intended to be used for this project. Incomplete submittal groupings will be returned “Rejected”. Submit shop drawing with identification mark number or symbol numbers as specified or scheduled on the Mechanical Drawings.
D. All submittals shall be project specific. Standard detail drawings and schedule not clearly indicating which data is associated with this Project will be returned “Rejected”.
E. Shop drawings shall be reviewed by the Mechanical Contractor for completeness and accuracy prior to submitting to the Architect/Engineer for review. The shop drawings shall be dated and signed by the Mechanical Contractor prior to submission.
F. No equipment shall be shipped from stock or fabricated until shop drawings for them have been reviewed by the Architect/Engineer. By the review of shop drawings, the Architect/Engineer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Mechanical Trades of full responsibility for the proper and correct execution of the work required.
G. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

1.12 COORDINATION DRAWINGS

A. Submit project specified coordination drawings for review in compliance with Division 01 Specification Sections.
B. Mechanical contractor responsible for coordination of all installed systems, including fire protection piping, plumbing piping, HVAC piping, ductwork, temperature controls components, lighting, electrical conduit and panels, ceiling, and architectural components.

1.13 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 Specification Sections.
B. Provide complete operation and maintenance instructional manuals covering all mechanical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals

are not acceptable. Four (4) copies of all literature shall be furnished for Owner and shall be bound in ring binder form. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.

C. Submit operation and maintenance manuals as PDF electronic files. Assemble each manual into a composite electronically indexed file. Submit on digital format media acceptable to Owner.

D. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:
   1. Routine maintenance procedures.
   2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
   3. Trouble-shooting procedures.
   4. Contractor's telephone numbers for warranty repair service.
   5. Submittals.
   6. Recommended spare parts lists.
   7. Names and telephone numbers of major material suppliers and subcontractors.
   8. System schematic drawings on 8-1/2" x 11" sheets.

1.14 RECORD DRAWINGS

A. Submit record drawings in compliance with Division 01.

B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or Mylar which have been neatly marked to represent as-built conditions for all new mechanical work.

C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.15 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of mechanical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.

C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

D. In addition to individual equipment training provide overview of each mechanical system. Utilize the as-built documents for this overview.

E. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction.

1.16 WARRANTY

A. Warranty: Comply with the requirements in Division 1 Specification Sections. Contractor shall warranty that the mechanical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this mechanical installation which becomes defective within a period of one year (unless specified otherwise in other Mechanical; Fire Suppression; Plumbing; or Heating, Ventilating and Air Conditioning Sections) from the date of project acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents. Contractor shall troubleshoot issues within 24 hours of notification by the Owner. Warranty shall include all parts, labor, travel time and expenses.

B. All warranty related issues must be addressed, and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.
C. File with the Owner, any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION WORK

A. All demolition of existing mechanical equipment and materials shall be done by the Contractor unless otherwise indicated. Include all items such as, but not limited to, existing piping, pumps, ductwork, supports and equipment where such items are not required for the proper operation of the modified system.
B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this Work.
C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Remove items from the systems and turn over to the Owner in their condition prior to removal. The Owner shall move and store these materials. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.
D. Work that has been cut or partially removed shall be protected against damage until covered by permanent construction.
E. Clean and flush the interior and exterior of all existing relocated equipment and its related piping, valves, and accessories that are to be reused of all mud, debris, pipe dope, oils, welding slag, loose mill scale, rust and other extraneous material so that the existing equipment and all accessories can be repainted and repaired as required to place in first-class working condition.
F. Where existing equipment is to be removed, cap piping under floor, behind face of wall, above ceiling or at mains.
G. Provide sheet metal caps on ductwork and cap piping immediately adjacent to demolition as soon as demolition commences to allow existing systems to remain in operation. Caps shall be of same material as service requiring such.

3.2 REFRIGERANT HANDLING

A. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:
    1. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.
    2. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.
    3. United States Environmental Protection Agency (US EPA) requirements of Section 8 08 (Prohibition of Venting and Regulation of CFC) and applicable State and Local regulations of authorities having jurisdiction.

B. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations. Provide documentation to Owner of quantity, type, and method of disposal.

3.3 WORK IN EXISTING BUILDINGS

A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.
B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.
C. Consult with the Owner's Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.
D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement, if necessary, of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.4 TEMPORARY SERVICES

A. Provide temporary service as described in Division 01.
B. The existing building will be occupied during construction. Maintain mechanical services and provide necessary temporary connections and their removal at no additional expense.

3.5 WORK INVOLVING OTHER TRADES

A. Certain items of equipment or materials specified in the Mechanical Division may have to be installed by other trades due to code requirements or union jurisdictional requirements. In such instances, the Contractor shall complete the work through an approved, qualified subcontractor and shall include the full cost for same in proposal.

3.6 ACCEPTANCE PROCEDURE

A. Upon successful completion of start-up and recalibration, but prior to building acceptance, substantial completion and commencement of warranties, the Architect/Engineer shall be requested in writing to observe the satisfactory operation of all mechanical control systems.
B. The Contractor shall demonstrate operation of equipment and control systems, including each individual component, to the Owner and Architect/Engineer.
C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect/Engineer for observation and approval.
D. After all items on the punch list are corrected and formal approval of the mechanical systems is provided by the Architect/Engineer, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.
E. Operation of the following systems shall be demonstrated:
    1. Air Handling Systems
    2. Chilled Water Systems.
    3. Heating Systems.
    4. Steam Pressure Reducing Stations.
    5. Condensate Receivers.
    6. Domestic Water Heaters.
    7. Chemical Treatment Systems.

8. Energy Recovery Systems.
9. Temperature Controls.
10. Building Automation System.
11. Exhaust Systems.
12. Welding Lab exhaust systems.

3.7 PROJECT COMMISSIONING

A. Refer to Division 01 “Project Commissioning” and the Commissioning Manual.
B. Purpose: Training, documentation and verification of the operation and functional performance of mechanical systems for compliance with the “design intent.”

END OF SECTION 20 0500

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SECTION 20 0510
BASIC MECHANICAL MATERIALS AND METHODS

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 Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 22 Section “Domestic Water Piping” for flushing and cleaning of potable water piping.
3. Division 23 Section “Piping Systems Flushing and Chemical Cleaning” for flushing and cleaning of HVAC piping.

1.2 SUMMARY

A. This section includes mechanical materials and installation methods common to mechanical piping systems, sheet metal systems and equipment. This section supplements all other Division 20, 21, 22, and 23 Mechanical Sections, and Division 01 Specification Sections.

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. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
D. 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.
E. 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.
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. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.
C. Comply with NSF 372, “Drinking Water System Components – Lead Content” for potable domestic water piping and components.
D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
E. 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.

F. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
G. Soldering: Qualify processes and operators according to AWS B2.3/2.3M, "Specification for Soldering Procedure and Performance Qualification."
H. Installer Qualifications:
   1. Installers of Grooved Components: Installers shall be certified by the grooved component manufacturer as having been trained and qualified to join piping with grooved couplings, fittings, and specialties.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Provide adequate weather protected storage space for all mechanical equipment and materials deliveries to the job site. Storage locations will be designated by the Owner's Representative. Equipment stored in unprotected areas must be provided with temporary protection.
   1. Protect equipment and materials from theft, injury or damage.
   2. Protect equipment outlets, pipe and duct openings with temporary plugs or caps.
   3. Materials with enamel or glaze surface shall be protected from damage by covering and/or coating as recommended in bulletin "Handling and Care of Enameled Cast Iron Plumbing Fixtures", issued by the Plumbing Fixtures Manufacturer Association, and as approved.
   4. Electrical equipment furnished by Mechanical Trades and installed by the Electrical Trades: Turn over to Electrical Trades in good condition, receive written confirmation of same.
   5. 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.
   6. 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. Coordinate with other trades to ensure accurate locations and sizes of mechanical spaces, chases, slots, shafts, recesses and openings.
B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
C. Install Work to avoid interference with work of other trades including, but not limited to, Architectural and Electrical Trades. Remove and relocate any work that causes an interference at Contractor's expense.
D. Coordinate requirements for and provide access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
E. The mechanical trades shall be responsible for all damage to other work caused by their work or through the neglect of their workers.
   1. All patching and repair of any such damaged work shall be performed by the trades which installed the work. The cost shall be paid by the Mechanical 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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21, 22, and 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. Refer to individual Division 21, 22, and 23 piping Sections for special joining materials not listed below.
B. Unions: Pipe Size 2 Inches and Smaller:
   1. Ferrous pipe: Malleable iron ground joint type unions.
   2. Unions in galvanized piping system shall be galvanized.
   3. Copper tube and pipe: Bronze unions with soldered joints.
C. Flanges: Pipe Sizes 2-1/2 Inch and Larger:
   1. Ferrous pipe: Standard weight, forged steel weld neck flanges.
   2. Copper tube and pipe: Slip-on bronze flanges.
D. 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.
E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated. Square head bolts and nuts are not acceptable.
F. Solder Filler Metals: ASTM B 32, lead-free, antimony-free, silver-bearing alloys. Include water-flushable flux according to ASTM B 813.
G. Brazing Filler Metals: Alloys meeting AWS A5.8, Use Type BCuP Series, silver-bearing, copper-phosphorus alloys for joining copper or bronze socket fittings with copper pipe. Flux is prohibited unless used with bronze fittings. Use Type Bag Series, cadmium-free silver alloys for joining copper with steel, stainless steel, or other ferrous alloys.
H. 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.
I. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
J. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
K. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 PIPE THREAD COMPOUNDS

A. Pipe thread compounds for the fluid service compatible with piping materials provided.
B. Compounds for potable water service and similar applications acceptable to U.S. Department of Agriculture (USDA) or Food and Drug Administration (FDA). Compounds containing lead are prohibited.
C. Inorganic zinc-rich coatings or corrosion inhibited proprietary compounds for galvanized carbon steel systems to coat raw carbon steel surfaces, in lieu of subsequent painting.
   1. Manufacturers:
      a. Carboline "Carbo-Zinc 12."
      b. Tnemec.
      c. Koppers.

D. Graphite and oil or proprietary corrosion inhibited compounds suitable for system temperatures for steam or condensate.
   1. Manufacturers:
      a. WKM; Division of Cooper Industries, Inc., Key "Graphite Paste."
      b. Other approved.
E. Use tetrafluoroethylene (Teflon) tape 2 to 3 mils thick for natural gas system threaded joints.
   1. Manufacturers:
      a. Cadillac Plastic.
      b. Permacel.
      c. Other approved.

2.5 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 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. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. IPEX Inc. (formerly Eslon Thermoplastics).
C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Thompson Plastics, Inc.
D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. NIBCO INC.
      b. NIBCO, Inc.; Chemtrol Div.
E. 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.
      e. Can-Tex Industries Division of Harsco Corp. “CT-Adaptors”.
      f. Joint Inc., “Caulder”.

2.6 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. Brass Unions, Brass Nipples, Brass Couplings: For systems up to 286 deg F.
D. Dielectric-Flange Kits: Include 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. Capitol Manufacturing Co.
        d. Central Plastics Company.
        e. Epco Sales, Inc.
        f. Pipeline Seal and Insulator, Inc.
        g. Watts Water Technologies, Inc.; Watts Regulator Co.
        h. Zurn Industries, Inc.; Wilkins Div.
    2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
E. Dielectric Nipple/Waterway Fittings: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, male NPT threaded, or grooved ends; and 300-psig minimum working pressure at 230 deg F.
    1. Manufacturers:
        a. Anvil International, Inc.; Gruvlok Manufacturing; DI-LOK Nipples.
        b. Elster Group; Perfection Corp.; ClearFlow.
        c. Precision Plumbing Products, Inc.; ClearFlow.
        d. Sioux Chief Manufacturing Co., Inc.
        e. Tyco Fire & Building Products; Grinnell Mechanical Products; Figure 407 ClearFlow.
        f. Victaulic Co. of America; Style 47 ClearFlow.
F. Stainless Steel Dielectric Unions: Class 3000 and 6000, for use in domestic water systems only, do not use for hydronic systems.
    1. O-Ring Seal: Located in thread piece.
        a. Compatible with system temperature.
        b. Not in contact with media.
    2. Interchangeable end connections.
    3. Thermo-baked epoxy polymer coating providing not less the 500 volts/mil dielectric resistance.
    4. Manufacturers:
        a. HART Industrial Unions, LLC.

2.7 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.; Innerlynx.
        b. Calpico, Inc.
        c. Metraflex Co.
        d. Pipeline Seal and Insulator, Inc.; Thunderline Link Seal.
    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.

2.8 SLEEVES

A. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall black.
B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall 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.

2.9 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping or Piping in High Humidity Areas: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping in Finished Spaces: One-piece, stamped-steel type.
      e. Bare Piping in Unfinished Service Spaces or Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping or Piping in High Humidity Areas: Split-casting, cast-brass type with chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
      c. Bare Piping: Split-plate, stamped-steel type with set screw or spring clips.

2.10 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.

2.11 EPOXY BONDING COMPOUND

A. Two-component system suitable for bonding wet or dry concrete to each other and to other materials.
B. Manufacturers:
   1. Euco 452 #450; Euclid Chemical Co.
   2. Epobond; L & M Construction Chemicals.
   3. Sikadur 87; Sika Corp.

2.12 LEAK DETECTOR SOLUTION

A. Commercial leak detector solution for pipe system testing.
B. Manufacturers:
   1. American Gas and Chemicals Inc.; Leak Tec.
   2. Cole-Parmer Inst. Co.; Leak Detector.
   3. Guy Speaker Co. Inc.; Squirt 'n Bubbles.

2.13 PIPE ROOF PENETRATION ENCLOSURES

A. Manufacturers:
   1. Pate Company (The); pca Series.
   2. Portals Plus, Inc.
   3. Thybar Corporation; Thycurb.
B. Minimum 18 gage welded galvanized steel construction.
C. Integral base plate.

D. Built-in fully mitered cant.
E. Factory installed insect and decay resistant wood nailer.
F. Factory installed 1-1/2 inch thick, 3 pounds per cubic foot density rigid insulation.
G. EPDM compression molded rubber cap for single or multiple pipes as required.
H. Stainless steel draw-band clamps.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Refer to piping application schedules on the Drawings.
B. Install piping according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems, and in accordance with manufacturer's instructions.
C. 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. The Drawings shall be followed as closely as elements of construction will permit.
D. During the progress of construction, protect open ends of pipe, fittings, and valves to prevent the admission of foreign matter. Place plugs or flanges in the ends of all installed work whenever work stops. Plugs shall be commercially manufactured products.
E. Prior to and during laying of pipe, maintain excavations dry and clear of water and extraneous materials. Provide minimum 4 inches of clearance in all directions for pipe passing under or through building grade beams.
F. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
G. Braze-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells in copper tube. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
H. Clean and lubricate elastomer joints prior to assembly.
I. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.
J. Install piping to conserve building space and not interfere with use of space.
K. Group piping whenever practical at common elevations.
L. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
M. Slope piping and arrange systems to drain at low points.
N. Slope horizontal piping containing noncondensible gases 1 inch per 100 feet, upward in the direction of the flow.
O. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
P. 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.
Q. In concealed locations where piping, other than black steel, cast-iron, or galvanized steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1-1/2 inches from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 1/16 inch thick steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 2 inches above sole plates and below top plates.
R. Do not penetrate building structural members unless specifically indicated on drawings.
S. Install piping above accessible ceilings to allow sufficient space for ceiling panel and light fixture removal.
T. Install valves with stems upright or horizontal, not inverted.

U. Provide clearance for installation of insulation and access to valves and fittings.
V. Install piping to permit valve and equipment servicing. Do not install piping below valves and/or terminal equipment. Do not install piping above electrical equipment.
W. Install piping at indicated slopes. Provide drain valves with hose end connections and caps at all piping low points, where piping is trapped and at all equipment.
X. Install piping free of sags and bends.
Y. Install fittings for changes in direction and branch connections.
Z. Unless otherwise indicated or specified, install branch connections to mains using tee fittings in main pipe:
    1. Branch connected to bottom of main pipe for HVAC systems. Side connection is acceptable. Connection above centerline of main is unacceptable. For up-feed risers, connect branch to top of main pipe.
    2. Branch connected to top of main for steam and condensate, plumbing systems, compressible gasses, and vacuum.
AA. Install piping to allow application of insulation.
BB. Select system components with pressure rating equal to or greater than system operating pressure.
CC. After completion, fill, clean, and treat systems. Refer to Division 23 Sections “Hydronic Piping,” “Piping Systems Flushing and Chemical Cleaning,” and “HVAC Water Treatment.”
DD. Install escutcheons for penetrations of walls below ceiling, and ceilings.
EE. Sleeves are not required for core-drilled holes in poured concrete walls.
FF. Permanent sleeves are not required for holes formed by removable PE sleeves in poured concrete walls.
GG. Install sleeves for pipes passing through footings and foundation walls, masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
    1. Cut sleeves to length for mounting flush with both surfaces of walls.
        a. Exception: Extend sleeves installed in floors 2 inches above finished floor level.
    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. Schedule 40 Black Steel Sleeves: For pipes smaller than NPS 12 penetrating interior walls.
        b. 0.375 Inch Wall Black Steel Sleeves: For pipes NPS 12 and larger penetrating interior walls.
        c. Schedule 40 Galvanized Steel Sleeves: For pipes smaller than NPS 12 penetrating floors, and roof slabs.
        d. 0.375 Inch Wall Galvanized Steel Sleeves: For pipes NPS 12 and larger penetrating floors and roof slabs.
    4. Seal sleeves in concrete floors roof slabs and masonry walls with grout.
    5. Seal sleeves in plaster/gypsumboard partitions with plaster or dry wall compound and caulk with non-hardening silicone sealant to provide airtight installation.
    6. 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.
HH. 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 Schedule 40 galvanized steel pipe for sleeves smaller than 12 inches in diameter.
    2. Install 0.375 galvanized steel pipe for sleeves 12 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.

II. New, Poured Concrete, Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Install water stop sleeves prior to pour. Seal pipe penetrations using modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.
   1. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical 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.

JJ. Existing Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Seal core drilled pipe penetrations using modular mechanical seals. Allow for 1-inch annular clear space between pipe and cored opening for installing modular mechanical seals.
   1. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of cored hole. Assemble modular mechanical seals and install in annular space between pipe and cored opening. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

KK. 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 Specification Sections for materials.

LL. Seal openings around pipes in sleeves and around duct openings through walls, floors and ceilings, and where floors, fire rated walls and smoke barriers are penetrated. Fire and/or smoke barriers shall be UL listed firestopping and shall have a fire rating equal to or greater than the penetrated barrier. Refer to Division 7 Specification Sections for materials.

MM. Pipe Roof Penetration Enclosures:
   1. Coordinate delivery of roof penetration enclosures to jobsite.
   2. Locate and set curbs on roof.
   3. Framing, flashing, and attachment to roof structure are specified under Division 07.
   4. Attach cap to curbs, cut pipe boots to fit pipe, and clamp boots to pipe or conduit.

NN. Verify final equipment locations for roughing-in.

OO. 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, 22, and 23 Sections specifying piping systems.

B. Cut piping square.

C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

D. Remove scale, slag, dirt, oil, and debris from inside and outside of pipe and fittings before assembly.

E. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.

F. Use standard long sweep pipe fittings for changes in direction. No mitered joints or field fabricated pipe bends will be permitted. Short radius elbows may be used where specified or specifically authorized by the Architect.

G. Make tee connections with screwed tee fittings, soldered fittings or specified welded connections. Make welded branch connections with either welding tees or forged branch outlet fittings in accordance with ASTM A234, ANSI B16.9 and ANSI B16.11. For forged branch outlets, furnish forged fittings flared for improved flow where attached to the run, reinforced against external strains and to full pipe-bursting strength requirements. "Fishmouth" connections are not acceptable.

H. Use eccentric reducers for drainage and venting of pipe lines; bushings are not permitted.
I. Provide pipe openings using fittings for all systems control devices, thermometers, gauges, etc. Drilling and tapping of pipe wall for connections is prohibited.
J. Provide temperature sensing device thermal wells and similar piping specialty connections.
K. Provide instrument connections except thermal wells with specified isolating valves at point of connection to system.
L. Locate instrument connections in accordance with manufacturers instructions for accurate read-out of function sensed. Locate instrument connections for easy reading and service of devices.
M. 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.
N. 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.
O. 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.
P. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
    1. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
Q. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on gaskets and bolt threads.
    1. Assemble flanged joints with fresh-stock gasket and hex head nuts, bolts or studs. Make clearance between flange faces such that the connections can be gasketed and bolted tight without strain on the piping system. Align flange faces parallel and bores concentric; center gaskets on the flange faces without projection into the bore.
    2. Lubricate bolts before assembly to insure uniform bolt stressing. Draw up and tighten bolts in staggered sequence to prevent unequal gasket compression and deformation of the flanges. Do not mate a flange with a raised face to a companion flange with a flat face; machine the raised face down to a smooth matching surface and use a full face gasket. After the piping system has been tested and is in service at its maximum temperature, check bolting torque to provide required gasket stress.
R. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer’s representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.
S. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials. Refer to Application Schedules on the Drawings.

T. Remake joints which fail pressure tests with new materials including pipe, fittings, gaskets and/or a filler.

3.3 ACCESS DOORS

A. Provide access doors for installation by architectural trades. Provide access doors in the walls, as required to make all valves, controls, coils, motors, air vents, filters, electrical boxes and other equipment installed by the Contractor accessible. Minimum size 12 inches x 12 inches. Provide access doors in the ceiling, for accessibility as mentioned above, 24 inches x 24 inches minimum size. Areas with accessible ceilings (ceilings where lay-in panels are not fastened in place and can be individually removed without removal of adjacent tiles) will not require access doors. Refer to Division 08 Section “Access Doors and Frames” for manufacturers and model numbers and additional information.

B. When access doors are in fire resistant walls or ceilings, they shall bear the Underwriters' Laboratories, Inc., Label, with time design rating equal to or greater than the wall or ceiling unless they were a part of the tested assembly.

3.4 EQUIPMENT CONNECTIONS

A. Make connections to equipment, fixtures, and other items included in the work in accordance with the submittals and rough-in measurements furnished by the manufacturers of the particular equipment furnished.
   1. Any and all additional connections not shown on the drawings but shown on the equipment manufacturer’s submittal or required for the successful operation of the equipment shall be installed as part of this Contract at no additional charge to the Owner.

B. All piping connections to pumps, coils, and other equipment shall be installed without strain at the pipe connection of this equipment. When directed, remove the bolts in flanged connections or disconnect piping to demonstrate that piping has been so connected.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.
   2. Install flanges, in piping NPS 2-1/2 and larger, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated. Housekeeping pad locations and sizes shall be coordinated by mechanical contractor prior to the placement of concrete slabs.

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.

E. For suspended equipment, furnish and install all inserts, rods, structural steel frames, brackets and platforms required. Obtain approval of Architect for same including loads, locations and methods of attachment.

F. Equipment Rigging Over Roof Areas: Protect building structure against damage during equipment rigging. Make provisions to distribute load of equipment to main roof structure, and to prevent damage to roof decking, roofing, or purlins.

G. The Contract Documents indicate items to be purchased and installed. The items are noted by a manufacturer's name, catalog number and/or brief description. The catalog number may not designate all the accessory parts for a particular application. Arrange with the manufacturer for the purchase of all items required for a complete installation.

3.7 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 09.
B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CONCRETE BASES

A. Concrete housekeeping pads for floor mounted mechanical equipment shall be provided by Architectural Trades.
B. 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 as shown on Drawings or specified, 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 03 Section.

3.9 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 mechanical materials and equipment.
C. Where pipe and/or equipment support members must be welded to structural building framing, Contractor shall seek prior approval from Architect and structural engineer. Scrape, brush clean, and apply one coat of zinc rich primer after welding.
D. Field Welding: Comply with AWS D1.1.

3.10 EPOXY BONDING TO EXISTING MATERIALS

A. Use epoxy bonding compound to set sleeves or pipes in existing concrete to bond new concrete and/or grout to existing materials or to bond dissimilar materials.
B. The compound, when applied in accordance with the manufacturer's instructions, shall be capable of initial curing within 48 hours at temperatures as low as 40 deg F and shall be capable of bonding any combination of the following properly prepared materials: Wet or dry, cured or uncured concrete or mortar; vitrified clay; cast iron and carbon steel.

3.11 JACKING OF PIPE

A. Do not jack pipe in place except upon prior approval of proposed materials and complete details of methods.

3.12 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.

3.13 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.

3.14 CUTTING, CORING AND PATCHING

A. Refer to Division 01 Specification Sections for requirements for cutting, coring, patching and refinishing work necessary for the installation of mechanical work.
B. All cutting, coring, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.15 EXCAVATION AND BACKFILLING

A. Refer to Division 31 Specification Sections.
B. Provide all excavation, trenching, tunneling and backfilling required for the mechanical work.
C. Provide all pumping and/or well pointing required for the mechanical work.
D. Provide foundations if required to support underground piping.
E. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

3.16 FLASHING

A. Provide all flashing required for mechanical work. Refer to Division 07 Specification Sections.

3.17 LUBRICATION

A. Provide all lubrication for the operation of the equipment until acceptance by the Owner. Contractor is responsible for all damage to bearings up to the date of acceptance of the equipment. Protect all bearings and shafts during installation. Thoroughly grease steel shafts to prevent corrosion. Provide covers as required for proper protection of all motors and other equipment during construction.

3.18 FILTERS

A. Provide and maintain filters in air handling systems throughout the construction period and prior to final acceptance of the building. Do not run air handling equipment, without all prefilters and final filters as specified.
B. Immediately prior to final building acceptance by the Owner, Contractor shall:

1. Replace all disposable type air filters with new units.

3.19 CLEANING

A. Each Mechanical Trade shall be responsible for removing all debris daily as required to maintain the work area in a neat, orderly condition.

B. After equipment, steam, condensate and HVAC water piping systems have been completed and tested, each entire system shall be cleaned and flushed. Refer to Division 23 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.

C. Prior to connection of new HVAC piping to existing HVAC piping systems, all new piping shall be subject to initial flushing, cleaning and final flushing. Refer to Division 23 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.

D. Flushing, cleaning, and disinfection of domestic water piping is specified in Division 22 Section “Domestic Water Piping.”

E. Exterior surfaces of all piping, ductwork and equipment shall be wiped down to remove excess dirt and debris prior to concealment by Architectural Trades work.

F. Upon completion of work in each respective area, clean and protect work. Just prior to final acceptance, perform additional cleaning as necessary to provide clean equipment and areas to the Owner.

END OF SECTION 20 0510

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SECTION 20 0513
MOTORS

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 Sections include the following:
   1. Division 20 “Mechanical General Requirements.”
   2. Division 20 Section "Mechanical Vibration Controls" for mounting motors and vibration isolation devices.
   3. Division 20 Section “Variable Frequency Controllers”.
   4. Division 21, 22, and 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.2 SUMMARY

A. This Section includes basic requirements for factory-installed and field-installed motors.

1.3 DEFINITIONS

A. ABMA: American Bearing Manufacturers Association. (Formerly AFBMA: Anti-Friction Bearing Manufacturers Association.)

B. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

C. Packaged Self-Contained Equipment: Equipment which includes component mechanical and electrical equipment mounted on common bases, skids or frames or

in common enclosures with internal control and power wiring factory installed and ready to accept a single electrical service connection. Provide the equipment complete with enclosed controllers, main disconnect switches, control transformers, control devices, wiring and accessories as required.

1.4 SUBMITTALS

A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.

B. Shop Drawings for Field-Installed Motors: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
   1. Each installed unit's type and details.
   2. Nameplate legends.
   3. Diagrams of power and control wiring. Provide schematic wiring diagram for each type of motor and for each control scheme.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around field-installed motors. Show motor layout, mechanical power transfer link, driven load, and relationship between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For testing agency.

E. Test Reports: Written reports specified in Parts 2 and 3.

F. Operation and Maintenance Data: For field-installed motors to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.

B. Source Limitations: Obtain field-installed motors of a single type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:
   1. Compatible with the following:
      a. Magnetic controllers.
      b. Variable frequency 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 electrical scope of work to be provided by Division 20, 22, and 23 with this Section, related Division 20, 21, 22, and 23 Specifications, Division 26 Specifications and the Drawings.

C. Electrical work provided under Division 20, 22, and 23: Furnish UL Listed components in accordance with this section, Division 26, and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.
D. Furnished, installed and wired under Division 20, 22, and 23 unless otherwise indicated:
   1. Disconnected components in packaged self-contained equipment that are so constructed that components of wiring must be disconnected for shipment and reconnected after installation.
E. Furnished and installed under Division 20, 22, and 23 and wired under Division 26 unless otherwise indicated:
   1. Motors required for mechanical equipment
   2. Packaged Self-Contained Equipment:
      a. Provide equipment ready to accept a single electrical service connection.
      b. For equipment with remote mounted control panels, provide mounting of the control panel and external wiring from the control panel to the package self-contained equipment.
   3. Variable frequency controllers.

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. Fuses: Quantity equal to 10 percent of each fuse type and size, but no fewer than 3 of each type and size.
   2. Spare Indicating Lights: Six of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Dayton.
   2. Toshiba Intl.
   3. Baldor Electric/Reliance.
   4. Rockwell Automation/Allen-Bradley.
   5. Nidec Motor Corporation; U.S. Motors.
   6. Regal Beloit/GE Commercial Motors.
   7. Regal Beloit/Leeson.
   8. Regal Beloit/Marathon.
   9. Siemens.

2.2 MOTOR REQUIREMENTS

A. Motor requirements apply to factory-installed and field-installed motors except as follows:
   1. Different ratings, performance, or characteristics for a motor are specified in another Section.
   2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
   3. Submersible motors integral to pumps and excluded from NEMA and EISA standards.
B. Electrical Power Supply Characteristics: Coordinate electrical system requirements with Division 26.
C. Electrical Power System Characteristics: As scheduled on the Drawings.

D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.

2.3 MOTOR CHARACTERISTICS

A. Motors 1/2 HP and Larger: Three phase, unless otherwise indicated.
B. Motors Smaller Than 1/2 HP: Single phase, unless otherwise indicated.
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. Brake Horsepower Input: Shall not exceed 90 percent of the rated motor horsepower.
I. Enclosure: Open dripproof (ODP) for motors installed indoors and out of the airstream. Totally-enclosed fan-cooled (TEFC) for motors installed outdoors or within the airstream.

2.4 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Fire pump motors, C-face motors, JP and JM frame motors, and motors over 200 horsepower shall be energy efficient motors. Efficiency of the motor shall be determined based on the NEMA MG1. The minimum efficiencies, nominal efficiencies and shall meet or exceed Table 12-11.

	1800 RPM OPEN DRIP-PROOF MOTORS 4 POLE		1800 RPM ENCLOSED MOTORS 4 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
1	82.5	81.5	82.5	81.5
1.5	84	82.5	84	82.5
2	84	82.5	84	82.5
3	86.5	85.5	87.5	86.5
5	87.5	86.5	87.5	86.5
7.5	88.5	87.5	89.5	88.5
10	89.5	88.5	89.5	88.5
15	91	90.2	91	90.2
20	91	90.2	91	90.2
25	91.7	91	92.4	91.7
30	92.4	91.7	92.4	91.7
40	93	92.4	93	92.4
50	93	92.4	93	93
60	93.6	93	93.6	93
75	94.1	93.6	94.1	93.6
100	94.1	93.6	94.5	94.1
125	94.5	94.1	94.5	94.1
150	95	94.5	95	94.5
200	95	94.5	95	94.5

	1200 RPM OPEN DRIP-PROOF MOTORS 6 POLE		3600 RPM OPEN DRIPPROOF MOTORS 2 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
1	80	78.5	--	--
1.5	84	82.5	82.5	81.5
2	85.5	84	84	82.5
3	86.5	85.5	84	82.5
5	87.5	86.5	85.5	84
7.5	88.5	87.5	85.5	86.5
10	90.2	89.5	88.5	87.5
15	90.2	89.5	89.5	88.5
20	91	90.2	90.2	89.5
25	91.7	91	91	90.2
30	92.4	91.7	91	90.2
40	93	92.4	91.7	91
50	93	93	92.4	91.7
60	93.6	93	93	92.4
75	93.6	93	93	92.4
100	94.1	93.6	93	92.4
125	94.1	93.6	93.6	93
150	94.5	94.1	93.6	93
200	94.5	94.1	94.5	94.1

C. Efficiency: Motors 1 horsepower to 200 horsepower shall be premium efficient motors meeting requirements of NEMA Premium Efficiency Motor Program. Efficiency of the motor shall be determined based on the NEMA MG1. The nominal efficiencies shall meet or exceed Table 12-12.

Nominal Efficiencies For "NEMA Premium™" Induction Motors
Rated 600 Volts or Less (Random Wound)

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1

Nominal Efficiencies For “NEMA Premium™” Induction Motors
Rated 600 Volts or Less (Random Wound)

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4

D. Stator: Copper windings, unless otherwise indicated.
E. Rotor: Squirrel cage, unless otherwise indicated.
F. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 120,000 hours. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
G. Temperature Rise: Match insulation rating, unless otherwise indicated.
H. Insulation: Class F, unless otherwise indicated.
I. Code Letter Designation:
   1. Motors 10 HP and Larger: NEMA starting Code (KVA Code) F or G.
   2. Motors Smaller Than 10 HP: Manufacturer's standard starting characteristic.
J. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.
   1. Finish: Gray enamel.
K. Sound Level: Not to exceed NEMA MG-1 12.54.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
B. Shaft Grounding: Provide a means to protect motor from common mode currents.
   1. Required for.
      a. Motors used with variable frequency controllers.
      b. Motors 100 HP and larger.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Electro Static Technology, Inc.; Aegis SGR Conductive Microfiber.
C. Source Quality Control: 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.

2.6 ELECTRONICALLY COMMUTATED MOTOR (ECM)

A. Furnish for equipment where specified or scheduled with ECM.
   1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
   2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.

3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
6. Integrated motor protection verified by UL to protect equipment against over-/undervoltage, overtemperature of motor, electronics, or both, overcurrent, locked rotor, and dry run (no-load condition).

2.7 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.

2.8 ENCLOSED CONTROLLERS

A. Provide enclosed controllers in accordance with requirements specified in Division 26 Section “Enclosed Controllers”.

2.9 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Provide enclosed switches and circuit breakers in accordance with requirements specified in Division 26 Section “Enclosed Switches and Circuit Breakers”.

2.10 FUSES

A. Provide fuses in accordance with requirements specified in Division 26 Section “Fuses”.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. All three phase motors 1/2 HP and above shall be tested by the Testing Agency.
B. Prepare for acceptance tests as follows:
   1. Check motor nameplates for H.P., speed, phase and voltage.
   2. Check coupling alignment and shaft end play.
   3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
   4. Test interlocks and control features for proper operation.
   5. Verify that current in each phase is within nameplate rating.
C. Testing: Perform the following field quality-control testing:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
   2. Jog motor as required to verify proper phase and shaft rotation. Immediately after start-up, check bearing temperature and smooth operation. Take current reading at full load using a clamp-on ammeter. If ammeter reading is over the rated full load current, determine reason for discrepancy and take necessary corrective actions. Record all readings, motor nameplate data and overload heater data.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with requirements.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Verify bearing lubrication.
   4. Verify proper motor rotation.
   5. Test Reports: Prepare a written report to record the following:
      a. Test procedures used.
      b. Test results that comply with requirements.
      c. Test results that do not comply with requirements and corrective action taken to achieve compliance.

3.2 ADJUSTING

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.3 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 20 0513

SECTION 20 0516
PIPE FLEXIBLE CONNECTORS, EXPANSION FITTINGS AND LOOPS

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 Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 23 Section “Refrigerant Piping.”

1.2 DEFINITIONS

A. BR: Butyl rubber.
B. CR: Chlorosulfonated polyethylene synthetic rubber (Neoprene).
C. CSM: Chlorosulfonyl-polyethylene rubber (Hypalon).
D. EPDM: Ethylene-propylene-diene terpolymer rubber.
E. NBR: Buna-N/Nitrile rubber.
F. NR: Natural rubber.
G. PTFE: Polytetrafluoroethylene plastic.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 150 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

A. Product Data: For each type of pipe flexible connector, expansion joint and alignment guide indicated.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.

C. Shop Drawings: Signed and sealed by a qualified professional engineer.
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.

D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

E. Welding certificates.

F. Operation and Maintenance Data: For pipe expansion joints to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: 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.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

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 FLEXIBLE CONNECTORS

A. Rubber Flexible Connectors/Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods or cables, and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
1. Manufacturers:
a. Flex-Weld, Inc./Keflex.
b. Mason Industries, Inc.; Mercer Rubber Co.
c. Metraflex, Inc.
d. Senior Flexonics, Inc.; Pathway Division.
e. Twin City Hose, Inc.
f. Vibration Mountings & Controls, Inc.
2. Arch Type: Single or multiple arches.
3. Spherical Type: Single or multiple spheres.
a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6: 140 psig at 200 deg F.

c. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12: 140 psig at 180 deg F.
4. Material: EPDM.
5. End Connections: Full-faced, integral, steel flanges with steel retaining rings and female union.
6. Coating: Factory applied Hypalon paint.

B. PTFE Flexible Connectors/Expansion Joints: Molded PTFE bellows with external reinforcing rings and external limit bolts.
1. Manufacturers:
a. Flex-Weld, Inc./Keflex.
b. Mason Industries, Inc.; Mercer Rubber Co.
c. Metraflex, Inc.
d. Senior Flexonics, Inc.; Pathway Division.
e. Twin City Hose, Inc.
f. Vibration Mountings & Controls, Inc.
2. Arch Type: Single or multiple arches.
3. End Connections: Full-faced, integral, ductile iron flanges.

C. Metal-Bellows Flexible Connectors: Circular-corrugated-bellows type with external tie rods and compression stops.
1. Manufacturers:
a. Adsco Manufacturing, LLC.
b. Flex-Weld, Inc./Keflex.
c. Hyspan Precision Products, Inc.
d. Metraflex, Inc.
e. Senior Flexonics, Inc.; Pathway Division.
f. Twin City Hose, Inc.
2. Metal-Bellows Flexible Connectors for Steel Piping: Multiple-ply 300 Series stainless-steel bellows.
3. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
4. Maximum Temperature Rating: 850 deg F.
5. End Connections: Flanged

D. Hose and Braid Flexible Connectors:
1. Manufacturers:
a. Adsco Manufacturing, LLC.
b. Flex-Weld, Inc.
c. Hyspan Precision Products, Inc.
d. Metraflex, Inc.
e. Senior Flexonics, Inc.; Pathway Division.
f. Twin City Hose, Inc.
2. Flexible Connectors for Copper Piping: Multiple-ply phosphor-bronze corrugated hose with bronze outer braid, copper ferrule, and copper pipe end connections.
3. Flexible Connectors for Steel Piping: Multiple-ply stainless-steel corrugated hose with stainless steel outer braid, and steel pipe end connections.
4. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
5. Maximum Temperature Rating: 450 deg F for copper piping connectors, 800 deg F for steel piping connectors.

2.3 EXPANSION JOINTS

A. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.
1. Manufacturers:
a. Flex-Hose Co., Inc.
b. Metraflex, Inc.; Metraloop.

c. Twin City Hose, Inc.

2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- or brazed- joint end connections.
   a. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with minimum 300 psig at 70 deg F and 230 psig at 400 deg F ratings.
   b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 230 psig at 70 deg F and 180 psig at 400 deg F ratings.
3. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged or weld end connections to match piping system for NPS 2-1/2 and larger.
   a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 450 psig at 70 deg F and 325 psig at 600 deg F ratings; and 300 psig maximum saturated steam pressure rating.
   b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 165 psig at 70 deg F and 120 psig at 600 deg F ratings; and 130 psig maximum saturated steam pressure rating.
   c. NPS 8 to NPS 12: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 160 psig at 70 deg F and 115 psig at 600 deg F ratings; and 90 psig maximum saturated steam pressure rating.

2.4 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:
      a. Adsco Manufacturing, LLC.
      b. Flex-Weld, Inc.
      c. Hyspan Precision Products, Inc.
      d. Metraflex, Inc.
      e. Senior Flexonics, Inc.; Pathway Division.

2.5 SLIDING/GUIDING DEVICES

A. For pipe size 4 inch and smaller on all hot piping, provide guides equal to Flexonics semi-steel spider and guiding cylinder pipe alignment guides for all expansion joints and loops. Provide pipe alignment guides in quantities at all locations as required according to the manufacturer's design criteria and recommendations. Pipe alignment guides shall serve to guide the expansion joints, loops or bends.
   1. Manufacturers:
      a. B-Line by Eaton; Figure 3281 Series.
      b. Senior Flexonics.
      c. Sypris Technologies; Tube Turns Division;
      d. U.S. Flexible Metallic Tubing Co., Kelflex Type M.
      e. Metraflex, Inc.

B. For pipe sizes 6 inches and above and all guides on cold piping, furnish pre-engineered pre-insulated guides with published vertical and lateral load ratings. Construction shall consist of an insulted shield containing structural calcium silicate (100 psi non-load bearing and 600 psi load bearing) encased in 360 degrees of overlapping sheet metal. A 36 steel clamps torqued onto insulated shield with recommended catalog torque valves. Slide service shall be stainless steel to polyethylene or Teflon with a maximum coefficient of friction of 0.15.
   1. Manufacturers:
      a. Pipe Shields, Inc. B3000, B4000, B7000 and B8000 series.
      b. Carpenter and Paterson, Inc.
      c. Rilco Mfg. HG 3000, HG 4000, HG 7000, and HG 8000 series.

2.6 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 minimum. Refer to 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: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 FLEXIBLE CONNECTOR APPLICATIONS

A. Use rubber flexible pipe connectors at the inlet and outlet water connections of base mounted pumps, chillers, and cooling towers, unless otherwise indicated.
   1. Rubber Flexible Connectors for Pipe Sized NPS 2 and Smaller: Twin-sphere with females union end connections.
   2. Rubber Flexible Connectors for Pipe Sized NPS 2-1/2 and Larger: Twin-sphere with floating flange end connections.
B. Flexible Connectors for Steam and Steam Condensate Service: Stainless steel hose and braid style with threaded end connections for pipe sized NPS 2 and smaller, and steel flange end connections for pipe sized NPS 2-1/2 and larger. Overall length sufficient to provide 1-1/2 inch offset.
C. Flexible Pipe Connectors for Refrigerant Pipe: Refer to Division 23 Section “Refrigerant Piping.”

3.2 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.
D. Install alignment guides at spacing recommended by expansion joint manufacturer.
E. Control expansion joint movement by installing two rigid pipe guides on each side of the expansion joint. Spacing shall be as follows:

Nom. Pipe Size	Exp. Joint to 1st	1st to 2nd	Maximum Distance Between Intermediate Guides (Ft.) For Tabulated pressures, PSIG							
(In.)	Guide	Guide	50	100	150	200	250	300	350	400
1	0'-4"	1'-4"	21	15	12					
1 1/4	0'-5"	1'-5"	23	17	13					
1 1/2	0'-6"	1'-9"	28	20	17					
2	0'-8"	2'-4"	32	23	18					
2 1/2	0'-10"	2'11"	35	28	22					
3	1'-0"	3'-6"	21	19	17	16	15	14	13	13
4	1'-4"	4'-8"	35	29	25	22	20	19	18	17
6	2'-0"	7'-0"	57	44	37	32	29	27	25	23
8	2'-8"	9'-4"	66	52	45	40	36	33	31	29
10	3'-4"	11'-8"	91	69	58	51	46	42	39	36
12	4'-0"	14'-0"	107	79	66	58	52	48	44	41
14	4'-8"	16'-4"	115	85	71	62	56	51	47	
16	5'-4"	18'-8"	127	94	78	68	61	56	52	
18	6'-0"	21'-0"	139	102	85	74	67	61	56	
20	6'-8"	23'-4"	151	110	91	80	71			
24	8'-0"	28'-0"	172	125	103	89	80			
30	10'-0"	35'-0"	200	144	118	103	92			

3.3 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.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion joints and bends and loops.

B. Attach guides to pipe and secure to building structure.

3.5 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 or compensators are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION 20 0516

SECTION 20 0519
METERS AND GAGES

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.

B. Related Sections include the following:

1. Division 22 Section "Water Distribution" for domestic and fire-protection water service meters outside the building.
2. Division 21 Section “Fire-Suppression Piping” for listed or approved pressure gages.
3. Division 20 Section “Mechanical General Requirements.”
4. Division 20 Section “Basic Mechanical Materials and Methods.”
5. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.
6. Division 23 Section "Steam and Condensate Piping" for steam and condensate meters.
7. Division 23 Section "Fuel Gas Piping" for gas utility meters.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FPR: Fiberglass reinforced plastic.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers, gages, flowmeters, and thermal-energy meters indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer, gage, flowmeter, and thermal-energy meter, signed by product manufacturer.

D. Operation and Maintenance Data: For flowmeters and thermal-energy meters to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

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 BIMETALLIC-ACTUATED DIAL THERMOMETERS

A. Manufacturers:
   1. AMETEK, Inc.; U.S. Gauge Div.
   2. Miljoco Corp.
   3. REO TEMP Instrument Corporation.
   4. Trerice, H. O. Co.
   5. Weiss Instruments, Inc.
   6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
B. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.
C. Case: Dry type, stainless steel with 5-inch diameter.
D. Element: Bimetal coil.
E. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
F. Pointer: Red metal.
G. Window: Glass or plastic.
H. Ring: Stainless steel.
I. Connector: Adjustable angle type.
J. Stem: Metal, for thermowell installation and of length to suit installation.
K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.
B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer. Brass for compatible services less than 353 degrees F; ANSI 18-8 stainless steel for all others to suit service. Furnish extension neck to accommodate insulation where applicable.

2.4 PRESSURE GAGES

A. Manufacturers:
   1. AMETEK, Inc.; U.S. Gauge Div.
   2. Cambridge.
   3. Dwyer Instruments, Inc.
   4. Marsh Bellofram.
   5. Miljoco Corporation.
   6. Trerice, H. O. Co.

7. Weiss Instruments, Inc.
8. 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: Stainless steel, aluminum, or FRP, 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: Glass or plastic.
8. Ring: Stainless steel or chrome plated metal.
9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
10. Water: 0-100 PSIG (1 psi divisions to 50 psi; 5 psi divisions above 50 psi), liquid filled.
11. Steam (15 psig and less): 30 inches Hg vacuum-30 PSIG (1 inch divisions below 0 psi; 1 psi divisions above 0 psi), silicone dampened.
12. Range for Fluids under Pressure: 1-1/2 times expected working pressure. If not a standard scale, select next largest scale.

C. Pressure-Gage Fittings:
1. Valves: NPS 1/4 brass ball 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. Manufacturers:
1. Peterson Equipment Co., Inc.
2. Miljoco Corporation.

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 for cold services, and 500 psig at 275 deg F for hot services.

D. Core Inserts: One or two self-sealing rubber valves.
1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be Neoprene.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be Nordel.

E. Test Kit: Furnish test kit(s) containing one pressure gage and adaptor, 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. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. 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.
4. Carrying case shall have formed instrument padding.

2.6 PITOT-TUBE FLOWMETERS

A. Manufacturers:
   1. Dieterich Standard Subsidiary of Rosemount Division of Emerson Process Management.
   2. Preso Meters Corporation.
   3. Taco, Inc.
   4. World Class Engineered Products, Inc.; PSE Division.
B. Description: Insertion-type, differential-pressure design for inserting probe into piping and measuring flow directly in gallons per minute.
C. Construction: Stainless-steel probe of length to span inside of pipe; with integral transmitter and direct-reading scale.
D. Pressure Rating: 150 psig minimum.
E. Temperature Rating: 250 deg F minimum.
F. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.
G. Integral Transformer: For low-voltage power connection.
H. Accuracy: Plus or minus 1 percent for liquids and gases.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install bimetallic-actuated dial thermometers in the following locations:
   1. Inlet and outlet of each hydronic zone.
   2. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
   3. Inlet and outlet of each hydronic heat exchanger.
B. 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. Steam and Condensate: 30 to 300 deg F, with 5-degree scale divisions.
   6. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages on inlet and outlet of each pressure-reducing valve.
B. Install dry-case-type pressure gages at chilled- and condenser-water inlets and outlets of chillers.
C. Install dry-case-type pressure gages at suction and discharge of each pump.
D. Except where noted otherwise, select range for twice normal operating pressure.
   1. Water (CW and HW): 0 to 100 psig.
   2. Steam (15 pounds): 30 inches mercury vacuum to 30 psig.
   3. Compressed Air: 0 to 160 psig.

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. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.
D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
E. Install ball valve and snubber fitting in piping for each pressure gage for fluids (except steam).

F. Install ball valve and syphon fitting in piping for each pressure gage for steam.
G. Install test plugs in tees in piping.
H. Install flow indicators, in accessible positions for easy viewing, in piping systems.
I. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.
J. Install flowmeter elements in accessible positions in piping systems.
K. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.
L. Install wafer-orifice flowmeter elements between pipe flanges.
M. Install permanent indicators on walls or brackets in accessible and readable positions.
N. Install connection fittings for attachment to portable indicators in accessible locations.
O. Install flowmeters at discharge of hydronic system pumps and at inlet of hydronic air coils.
P. Assemble components and install thermal-energy meters.
Q. Mount meters on wall if accessible; if not, provide brackets to support meters.

3.4 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.
B. Connect flowmeter-system elements to meters.
C. Connect flowmeter transmitters to meters.
D. Ground equipment according to Division 26 Section "Grounding and Bonding."
E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 ADJUSTING

A. Calibrate meters according to manufacturer's written instructions, after installation.
B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 20 0519

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SECTION 20 0529
HANGERS AND SUPPORTS

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 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 20 Section “Mechanical General Requirements.”
3. Division 20 Section “Basic Mechanical Materials and Methods.”
4. Division 20 Section "Mechanical Vibration Controls" for vibration isolation devices.
5. Division 20 Section "Pipe Expansion Fittings and Loops" for pipe guides and anchors.
6. Division 21 Section "Fire-Suppression Piping" for pipe hangers for fire-protection piping.
7. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. MFMA: Metal Framing Manufacturers Association.

1.3 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.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.

1.5 QUALITY ASSURANCE

A. MSS Standards: Pipe hangers, supports, and accessories shall comply with the following:
   1. MSS SP-58, Pipe Hangers and Supports – Materials, Design and Manufacture.
   2. MSS SP-69, Pipe Hangers and Supports – Selection and Application.
   3. MSS SP-89, Pipe Hangers and Supports – Fabrication and Installation Practices.

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 HANGER ROD MATERIAL

A. Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575.
   1. Rod continuously threaded.
   2. Use of rod couplings is prohibited.

2.3 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-69, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article, and schedules and details on the Drawings for where to use specific hanger and support types.
   1. Hangers and Supports for Fire Protection Piping: UL listed or FMG approved.
B. Manufacturers:
   1. Anvil International, Inc.
   2. B-Line by Eaton.
   3. Carpenter & Paterson, Inc.
   4. Hilti USA.
   5. ERICO International Corp.
   6. PHD Manufacturing, Inc.
C. Nonmetallic Coatings: Plastic coating, jacket, or liner.
D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.4 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.

2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
   1. Anvil International, Inc.; Anvil-Strut.
   2. B-Line by Eaton.
   3. Power-Strut Div.; Tyco International, Ltd.
   4. Unistrut Corp.; Tyco International, Ltd.
   5. Hilti USA.
C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
D. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
E. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 METAL INSULATION SHIELDS

A. Manufacturers:
   1. Anvil International, Inc.
   2. B-Line by Eaton.
   3. Carpenter & Paterson, Inc.
   4. ERICO International Corp.
   5. PHD Manufacturing, Inc.
B. Description: MSS SP-69, Type 40, protective shields. Shields shall span an arc of 180 degrees.
C. Shield Dimensions for Pipe: Not less than the following:
   1. NPS 1/4 to NPS 2: 12 inches long and 0.048 inch thick.

2.7 PIPE COVERING PROTECTION SADDLES

A. Manufacturers:
   1. Anvil International, Inc.
   2. B-Line by Eaton.
   3. Carpenter & Paterson, Inc.
   4. ERICO International Corp.
   5. PHD Manufacturing, Inc.
B. Description: MSS SP-69, Type 39A and Type 39B, for suspension of insulated hot pipe where heat losses are to be kept to a minimum.
   1. Saddles shall match insulation thickness.
   2. Saddle length: 12 inches.
   3. Furnish with center rib for pipe sized NPS 12 and larger.

2.8 THERMAL-HANGER SHIELDS

A. Manufacturers:
   1. B-Line by Eaton.
   2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
   3. Rilco Manufacturing Company, Inc.
   4. American Mechanical Insulation Sales Inc. (AMIS).
   5. ERICO International Corp.
   6. Value Engineered Products, Inc.
B. Description: Manufactured assembly consisting of insulation insert encased in 360 degree sheet metal shield.
   1. Minimum Compressive Strength of Insert Material:
      a. 100-psig- for sizes smaller than NPS 6.
      b. 600-psig- for sizes NPS 6 and larger.
C. Insulation-Insert Material for Cold Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
D. Insulation-Insert Material for Hot Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate.
E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

F. Include carbon steel ASTM A36 load distribution plates as required by load, pipe movement, hanger style, and hanger spacing.
G. Thermal-Hanger Shields for Flexible Foamed Elastomeric Insulated Piping:
   1. Manufacturer:
      a. B-Line by Eaton/Armacell; Armafix IPH.
   2. Insulation-Insert Material for Copper Piping with Flexible Foamed Elastomeric Insulation: Use the following:
      a. Flexible foamed elastomeric, ASTM 534, Type I-Tubular Grade 1 with PUR/PIP support inserts.
H. Thermal-Hanger Shields for Small Diameter Piping:
   1. Manufacturer:
      a. Hydra-Zorb Company; Klo-Shure Insulation Couplings.
   2. Insulation-Insert Material for Small Diameter Piping with Flexible Foamed Elastomeric or Glass Fiber Insulation: Use the following:
      a. Rigid Hytrel thermoplastic insulation coupling designed for use with pipe or tube NPS 1-1/2 and smaller, and insulation from 3/8 inch to 1-1/2 inch thick.

2.9 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated 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 by Eaton.
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head.
      e. MKT Fastening, LLC.
      f. Powers Fasteners.
B. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application. Exception: Do not use chemical fasteners to support hanger systems for fire protection piping.
   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. MKT Fastening, LLC.
      d. Powers Fasteners.
   2. 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.
   3. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
   4. Washer and Nut: Zinc-coated steel.

2.10 ROOF MOUNTED PIPING SUPPORTS

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
B. Low, Adjustable-Height, Single-Base Stand: Assembly of base, horizontal member, and adjustable vertical members, and pipe support, for roof installation without membrane penetration.
   1. Manufacturers:
      a. B-Line by Eaton; Dura-Blok.
      b. Eco Support Products.
      c. MIFAB, Inc.; C-port.
      d. MIRO Industries; Conduit and Condensate Supports.

e. Pentair Electrical & Fastening Solutions; CADDY.
f. Portable Pipe Hangers.
2. Base: Plastic, stainless steel, or recycled rubber.
3. Horizontal Member: Cadmium-plated-steel or galvanized-steel strut designed for use with standard strut clamps and accessories.
4. Vertical Members: Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575 with cadmium plated nuts and washers. Rod continuously threaded.

C. Low, Fixed-Height, Single-Base Roller Stand: Assembly of base and horizontal roller, for roof installation without membrane penetration.
1. Manufacturers:
a. B-Line by Eaton; Dura-Blok.
b. Eco Support Products.
c. MIFAB, Inc.; C-port.
d. MIRO Industries; Conduit and Condensate Supports.
e. Pentair Electrical & Fastening Solutions; CADDY.
f. Portable Pipe Hangers.
2. Base: Plastic, stainless steel, or recycled rubber.
3. Horizontal Member: Cadmium-plated-steel rod and corrosion resistant roller designed for use with standard accessories.

D. Low, Adjustable-Height, Single-Base Roller Stand: Assembly of base and horizontal roller, for roof installation without membrane penetration.
1. Manufacturers:
a. B-Line by Eaton; Dura-Blok.
b. Eco Support Products.
c. MIFAB, Inc.; C-port.
d. MIRO Industries; Conduit and Condensate Supports.
e. Pentair Electrical & Fastening Solutions; CADDY.
f. Portable Pipe Hangers.
2. Base: Plastic, stainless steel, or recycled rubber.
3. Horizontal Member: Cadmium-plated-steel rod and corrosion resistant roller designed for use with standard accessories.
4. Vertical Members: Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575 with cadmium plated nuts and washers. Rod continuously threaded.

2.11 ROOF MOUNTED EQUIPMENT SUPPORTS

A. Equipment Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted equipment.

B. Non-Penetrating Equipment Supports: Assembly of two or more bases and horizontal members, for roof installation without membrane penetration.
1. Manufacturers:
a. B-Line by Eaton; Dura-Blok.
b. Eco Support Products.
c. MIFAB, Inc.; C-Port.
d. MIRO Industries; HD and LD Mechanical Unit Supports.
e. Pentair Electrical & Fastening Systems; CADDY.
f. Portable Pipe Hangers.
2. Base: Plastic, stainless steel, or recycled rubber.
3. Horizontal Member: Cadmium-plated-steel, galvanized-steel, or stainless steel strut, and planking; designed for use with standard strut clamps, all-thread rood, and accessories.

2.12 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.13 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. Refer to application schedules on the Drawings.
B. For insulated pipe, oversize hanger elements to accommodate insulation thickness.
C. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
D. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
E. Use hangers and supports with galvanized, metallic coatings for outdoor applications or where exposed to outdoor conditions.
F. Use hangers and supports with plastic coating, or galvanized metallic coatings for applications in corrosive atmospheres.
G. Use metal framing, with plastic coating, or galvanized metallic coatings for metal framing in corrosive atmospheres.
H. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
I. Use padded hangers for piping that is subject to scratching.
J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. MSS Type 8 or spring type to meet system requirements.
K. 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 for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F 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 piping installations.
L. Concrete Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Anchor Devices, Concrete and Masonry: in accordance with Group I, Group II, Type 2, Class 2, Style 1 and Style 2, Group III and Group VIII or FS FF-S-325A. Furnish cast-in floor type equipment anchor devices with adjustable positions. Furnish built in anchor devices for masonry, unless otherwise approved by the Architect. Powder actuated anchoring devices shall not be used to support any mechanical systems components.
   2. Use mechanical-expansion anchors where required in concrete construction.
   3. Use chemical fasteners where required in concrete construction.
M. Steel Frame Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Beam Clamps:
      a. Center Loading: TYPE 21, 28, 29 and 30, unless otherwise indicated. Type 27 shall be allowed to support single pipes NPS 6 size or smaller only.

b. "C" Clamps: Type 19, 20 or 23, for supporting single pipes NPS 2-1/2 size or smaller only. Use of "C" clamps, or beam clamps of "C" pattern, or any modification thereof, is prohibited for supporting multiple pipes or pipes larger than NPS 2-1/2.

N. Hanger-Rod Attachments for Wood Construction: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. All Steel Ceiling Plates: UL listed and suitable for attachment to wood beams. For pipe sizes NPS 1/2 to NPS 2. Install in accordance with manufacturer's instructions to maintain listing.
   2. Threaded Side Beam Brackets: UL listed and FMG approved, suitable for attachment to wood beams. For pipe sizes NPS 2 to NPS 4. Install in accordance with manufacturer's instructions to maintain listing.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Use spring supports and sway braces TYPES 48, 49, 50, 51, 52, 53, 54, 55 or 56. For specific points:
      a. Provide spring supports at point of support where vertical movement will occur.
      b. For light loads and vertical movement less than 1/4 inch, TYPES 48 or 49 spring cushion supports.
      c. For vertical movements in excess of 1/4 inch but less than 1/2 inch, TYPES 51, 52 or 53 variable spring supports shall be used, loaded to not more than 75 percent of published load rating.
      d. For vertical movements of 1/2 inch and more, TYPES 54, 55 and 56 constant support spring hangers.
      e. Sway braces; TYPE 50.
      f. Variable spring hangers in accordance with referenced MSS Standards with "medium" allowable load change.

P. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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 structural frame.

B. Provide necessary piping and equipment supporting elements including: building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, other pipe, duct or equipment.

C. At connections between piping systems, hangers and equipment of dissimilar metals, insulate, using dielectric insulating material, nonferrous piping against direct contact with the building steel by insulating the contact point of the hanger and pipe or the hanger and building steel. Test each point of dielectric insulation with an ohm meter to ensure proper isolation of dissimilar materials. Test shall be observed by the Owner's Representative and/or Architect.

D. Use copper plated or plastic coated supporting element in contact with copper tubing or glass piping.

E. File and paint cut ends and shop or field prime paint supporting element components.

F. Hang piping parallel with the lines of the building, unless otherwise indicated. Route piping in an orderly manner and maintain gradient. Space piping and components so a threaded pipe fitting may be removed between adjacent pipes and so there will be

not less than 1/2 inch of clear space between finished surfaces and piping. Arrange hangers on adjacent parallel service lines in line with each other.

G. Flange loads on connected equipment shall not exceed 75 percent of maximum allowed by equipment manufacturer. Flange loads in liquid containing systems shall be checked in the presence of the Architect when piping is full of liquid. No flange load is allowed on pumps, vibration isolated equipment or flexible connectors.
H. Spring supports, within specified limitations: Constant support type, where necessary to avoid transfer of load from support to support or onto connected equipment; otherwise, variable support type located at points subject to vertical movement.
I. Incorporate pipe anchors into piping systems to maintain permanent pipe positions. Install alignment guides for the piping adjacent to and on each side of pipe expansion loops and expansion joints to maintain alignment.
J. Where necessary, brace piping and supports against reaction, sway and vibration.
K. Do not hang piping from concrete joist pans, floor decks, roof decks, equipment, ductwork, or other piping.
L. Install turnbuckles, swing eyes and clevises to accommodate temperature changes, pipe accessibility, and adjustment for load pitch. Rod couplings are not acceptable.
M. Install hangers and supports for piping at intervals specified, at locations not more than 3 feet from the ends of each runout, not more than 3 feet from connections to equipment, and not over 25 percent of specified interval from each change in direction of piping and for concentrated loads such as valves, etc.
N. Base the load rating for pipe support elements on loads imposed by insulated weight of pipe filled with water. The span deflection shall not exceed slope gradient of pipe.
O. If structural steel, roofs, or tunnels will allow support spacing greater than that shown above, Contractor shall submit proposed support system along with structural calculations documenting the allowance of such spacing, in accordance with ANSI, B31.1, and MSS Guidelines.
P. Support vertical risers independently of connected horizontal piping whenever practical, with supports at the base and at intervals to accommodate system range of load with thermal conditions. Support vertical risers at each floor penetration for piping in shafts or chases. Guide for lateral stability. Fit horizontal piping connected to moving risers with two spring supports connected adjacent to riser, spaced according to required hanger spacing.
Q. For risers at temperatures of 100 deg F or less place riser clamps under fittings. Support carbon steel pipe at each operating level or floor and at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20 foot intervals for pipe 2-1/2 inches and larger.
R. After the piping systems have been installed, tested and placed in satisfactory operation, firmly tighten hanger rod nut and jam nut and upset threads to prevent movement of fasteners.
S. Attach pipe anchors and pipe alignment guides to the building structure where indicated. If not indicated, the method used is optional to the Contractor, subject to approval by the Architect. In the case of structural steel, make attachment by clamping in accordance with the American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Building.
T. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure.
U. Attach pipe hangers and other supporting elements to roof purlins and trusses at panel points.
V. Where eccentric loading beam clamps are approved and where other work is supported by similar eccentric loading support element from the same structural member, locate eccentric loading support elements to minimize structural member torsion load.
W. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.

X. Building structure shall not be reinforced except as approved by the Architect in writing.
Y. Use approved cast-in-place inserts or built-in anchors for attachment to concrete structure. Size inserts and anchors for the total applied load with a safety factor in accordance with applicable codes but in no case less than 5. Coordinate installation of all imbedded items in accordance with manufacturer's instructions. Position anchorage and imbedded items as indicated and/or where required and support against displacement during placing of concrete. Cutting or repositioning of concrete beam or girder or reinforcing steel to accommodate inserts will not be allowed. Provide removable closures in imbedded device openings to prevent entry of concrete.
Z. Support piping and equipment from concrete building frame, not from roof or floor slabs unless otherwise indicated.
AA. Use cast-in-place inserts in concrete beams and girders. Drilled anchors/wedge type inserts shall be used on vertical surfaces only. Coordinate with structural engineer.
BB. Attach piping supports to the side of concrete beams and concrete joist. Provide supplementary support steel as required. Cast-in-place or drilled anchors will not be permitted in the bottom of concrete beams and concrete joist.
CC. Attach piping supports to the side of concrete beams or concrete joist. Where intermediate hangers are required to meet the hanger spacing schedule, the Contractor may propose attachment of intermediate pipe supports to the bottom of the concrete slab pending submittal of a satisfactory pull out test. The Contractor shall submit pull out test criteria, pull out test results, proposed hanger detail and hanger point loads to the Architect for written approval.
DD. 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.
EE. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
FF. Fastener System Installation:
    1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
GG. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
HH. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
II. 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.
JJ. Install lateral bracing with pipe hangers and supports to prevent swaying.
KK. 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.
LL. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
MM. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

NN. Refer to individual piping sections for hanger spacing and hanger rod sizes.

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. Equipment Supports: Painting is specified in Division 09 painting Sections.
C. 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.
D. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 20 0529

SECTION 20 0547
MECHANICAL VIBRATION 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. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 ACTION SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device.

1.3 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Installation of these items is specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION EQUIPMENT BASES

A. **Type A**: Direct Isolator Attachment
   1. Unit to be isolated is so constructed that vibration isolators of the type specified may be directly attached, provided that the edge deflection of the isolated unit base over unsupported span between mountings does not exceed specified or manufacturer's limits. If units to be isolated will not meet required deflection provisions, Type B bases shall be provided.

B. **Type B**: Factory-fabricated, welded, structural-steel bases or rails.
   1. Structural Steel Bases:

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type WF or a comparable product by one of the following:
   1) Amber/Booth; a VMC Group Company.
   2) Kinetics Noise Control, Inc.
   3) Korfund Dynamics; a VMC Group Company.
   4) Vibration Eliminator Co., Inc.
   5) Vibration Isolation Co., Inc. (Pump Bases Only)
   6) Vibration Mountings & Controls; a VMC Group Company.
   7) Vibro-Acoustics.
b. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
d. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2. Structural-Steel Rails:
   a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ICS or a comparable product by one of the following:
      1) Amber/Booth; a VMC Group Company.
      2) Kinetics Noise Control, Inc.
      3) Korfund Dynamics; a VMC Group Company.
      4) Vibration Eliminator Co., Inc.
      5) Vibration Isolation Co., Inc. (Pump Bases Only)
      6) Vibration Mountings & Controls; a VMC Group Company.
      7) Vibro-Acoustics.
   b. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
   c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
   d. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. **Type C** Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type BMK/KSL or a comparable product by one of the following:
      a. Amber/Booth; a VMC Group Company.
      b. Kinetics Noise Control, Inc.
      c. Korfund Dynamics; a VMC Group Company.
      d. Vibration Eliminator Co., Inc.
      e. Vibration Isolation Co., Inc. (Pump Bases Only)
      f. Vibration Mountings & Controls; a VMC Group Company.
      g. Vibro-Acoustics.
   2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

D. **Type D** Curb Mounted Aluminum Bases:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type CMAB or a comparable product by one of the following:
   a. Kinetics Noise Control, Inc.
   b. ThyCurb/Thybar.
   c. Vibro-Acoustics.
   d. Vib-Iso.
2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.
3. Upper Frame: Corrosion resistant extruded aluminum. Upper frame shall overlap lower frame for water runoff. Mitered ends heliarc welded to prevent water leakage through corners.
4. Lower Frame: Corrosion resistant extruded aluminum. Lower framed shall overlap roof curb for water runoff. Mitered ends heliarc welded to prevent water leakage through corners.
5. Safety Stops: Neoprene, mounted in corners of lower frame for extreme wind conditions and mild seismic disturbances under normal conditions.
6. Isolators: Cadmium plated free-standing springs with positive spring retainer and flexible ties.
7. Splicing Kit: Required for bases shipped in multiple pieces.
8. Weatherseal: Flexible frictionless EPDM.
9. Static Deflection: Nominal 1 inch.

E. **Type E** Rooftop Spring Curb:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type RSC or a comparable product by one of the following:
   a. Kinetics Noise Control, Inc.
   b. ThyCurb/Thybar.
   c. Vibro-Acoustics.
2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment; and to withstand wind forces as required by local codes.
3. Lower Support Assembly: Sheet-metal "Z" section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
4. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
   a. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with restraint.
      1) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.

2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
4) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

b. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers (maximum 3 layers separated by steel shims) to achieve 90 percent efficiency, 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: Bridge-bearing neoprene, complying with AASHTO M 251.
2) Durometer Rating: 40.

5. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
6. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.
7. Sound Isolation: Within perimeter of roof curb rails and as detailed on the Drawings:
a. Two layers of 2-inch thick board insulation, minimum 3-lb/cu. ft. density, glass fibers bonded with a thermosetting resin. Comply with ASTM C 612 Type IA or Type IB.
b. Two layers of 5/8-inch thick water-resistant gypsum core wall panel surfaced with paper on front, back, and long edges. Comply with ASTM C 1396.
c. One layer of 6-inch thick fiberglass blanket insulation.
8. Static Deflection: Nominal 1 inch, 2 inches, or 3 inches.

2.2 VIBRATION ISOLATORS

A. **Type 1a** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, arranged in single or multiple layers (maximum 3 layers separated by steel shims) to achieve 90 percent efficiency, 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. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type W, Super W, WSW, and WSWSW or comparable products by one of the following:
a. Amber/Booth; a VMC Group Company.
b. Kinetics Noise Control, Inc.
c. Korfund Dynamics; a VMC Group Company.
d. Vibration Eliminator Co., Inc.
e. Vibration Mountings & Controls; a VMC Group Company.
f. Vibro-Acoustics.
2. Material: Standard neoprene for indoor applications.
3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.

B. **Type 1b** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, single layer, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and 1/4 inch steel load bearing plate. Factory cut to sizes that match requirements of supported equipment.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type Super WMSW and MBSW or a comparable product by one of the following:

a. Amber/Booth; a VMC Group Company..
b. Kinetics Noise Control, Inc.
c. Korfund Dynamics; a VMC Group Company.
d. Vibration Eliminator Co., Inc.
e. Vibration Mountings & Controls; a VMC Group Company.
f. Vibro-Acoustics.

2. Material: Standard neoprene for indoor applications.
3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.

C. **Type 2** Elastomeric Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ND or a comparable product by one of the following:
a. Amber/Booth; a VMC Group Company..
b. Kinetics Noise Control, Inc.
c. Korfund Dynamics; a VMC Group Company.
d. Vibration Eliminator Co., Inc.
e. Vibration Mountings & Controls; a VMC Group Company.
f. Vibro-Acoustics.

2. Durometer Rating: Selected for maximum possible static deflection with the loading of each piece of equipment.
3. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
4. Neoprene: Bridge-bearing neoprene as defined by AASHTO.

D. **Type 3** Spring Isolators: Freestanding, open-spring isolators.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type SLF or a comparable product by one of the following:
a. Amber/Booth; a VMC Group Company.
b. Kinetics Noise Control, Inc.
c. Korfund Dynamics; a VMC Group Company.
d. Vibration Eliminator Co., Inc.
e. Vibration Mountings & Controls; a VMC Group Company.
f. Vibro-Acoustics.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. **Type 4** Restrained Spring Isolators: Restrained single and multiple spring mounts.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Types SLR and SLRS or comparable products by one of the following:
a. Amber/Booth; a VMC Group Company.
b. Kinetics Noise Control, Inc.
c. Korfund Dynamics; a VMC Group Company.
d. Vibration Eliminator Co., Inc.
e. Vibration Mountings & Controls; a VMC Group Company.

f. Vibro-Acoustics.

2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. **Type 5** Thrust Restraints

1. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression or tension as required, and with a load stop. Include rod and angle-iron brackets with back-up plates for attaching to equipment and ductwork.
   a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type WBI for fan inlet connections, and Type WBD for fan outlet connections, or comparable products by one of the following:
      1) Amber/Booth; a VMC Group Company..
      2) Kinetics Noise Control, Inc.
      3) Korfund Dynamics; a VMC Group Company.
      4) Vibration Eliminator Co., Inc.
      5) Vibration Mountings & Controls; a VMC Group Company.
      6) Vibro-Acoustics.
   b. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   e. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
   f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   g. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   h. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.3 VIBRATION ISOLATION HANGERS

A. **Type 8a** Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type 30N or a comparable product by one of the following:
   a. Amber/Booth; a VMC Group Company.
   b. Kinetics Noise Control, Inc.
   c. Korfund Dynamics; a VMC Group Company.
   d. Vibration Eliminator Co., Inc.
   e. Vibration Mountings & Controls; a VMC Group Company.
   f. Vibro-Acoustics.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

B. **Type 8b** Spring Hangers with Vertical-Limit Stop: Precompressed combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type PC30N or a comparable product by one of the following:
a. Amber/Booth; a VMC Group Company.
b. Kinetics Noise Control, Inc.
c. Korfund Dynamics; a VMC Group Company.
d. Vibration Eliminator Co., Inc.
e. Vibration Mountings & Controls; a VMC Group Company.
f. Vibro-Acoustics.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.
B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install roof curbs, equipment supports, and roof penetrations as specified in Division 07 Section "Roof Accessories."
B. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

3.3 APPLICATION

A. Refer to Vibration Isolator Application Schedule on the drawings for isolator application and minimum deflection.

3.4 CONNECTIONS

A. Provide flexible electrical connections in the form of large radius, 360 degree loop of flexible conduit for all vibrating isolated equipment. Any cooling water lines, compressed air, or other piping services (except inlet and outlet water connections for pumps, chillers or cooling tower) shall be made with 360 degree loops of reinforced neoprene hose, which are attached using nipples of appropriate gender. All service connections made with neoprene hose shall have shut-off valves between the hose and the supply service.

B. Vibration isolate piping connected to vibration isolated equipment using Type 8a or 8b spring hangers, and with distance to be isolated as scheduled on the Drawings. Maximum spacing between isolators same as maximum distance between pipe hangers and supports.

C. Vibration isolate ductwork connected to air handling units, return air fans, and vibration isolated equipment using Type 8a or 8b spring hangers, and in accordance with isolation distances scheduled on the Drawings.

3.5 EQUIPMENT BASES

A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.
   1. Cast-in-place concrete materials and placement requirements are specified in Division 03.

B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions.
   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 the base.
   2. Install epoxy-coated anchor bolts for supported equipment 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.
   5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.6 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:
   1. Isolator deflection.
   2. Snubber minimum clearances.

3.7 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

D. Adjust active height of spring isolators.

E. Adjust snubbers according to manufacturer's written recommendations.

3.8 CLEANING

A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION 20 0547

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SECTION 20 0553
MECHANICAL IDENTIFICATION

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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”

1.2 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.

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME (ANSI) 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.

1.4 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 location of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
   1. Seton.
   2. Brady.
   3. EMED.
   4. Craftmark.
   5. Brimar Industries, Inc.
   6. Marking Services Inc. (MSI).
   7. Kolbi Pipe Marker Co.

2.2 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, white with black lettering laminated plastic. For permanent (mechanically fastened) attachment on equipment.
   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: Minimum 1/16 inch, unless otherwise indicated.
   4. 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.

2.3 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 (ANSI) A13.1, unless otherwise indicated.
   2. Type and Size of Letters: Comply with ANSI A13.1, unless otherwise indicated.
   3. Legends: Spelled out in full or commonly used and accepted abbreviations.
   4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
   5. 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.
   6. 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. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4mil thick, manufactured for direct burial service.
F. Detectable Underground Pipe Markers: Continuously printed plastic ribbon tape with detectable aluminum core and with colors meeting APWA requirements, not less than 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.4 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Vinyl, 2-inch minimum character height, with permanent pressure sensitive adhesive. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust).

2.5 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/Engineer. Provide 5/32-inch hole for fastener.
   1. Material: 0.032-inch- thick brass.
   2. Valve-Tag Fasteners: Brass wire-link chain or beaded chain.

2.6 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: Finished hardwood or extruded aluminum.
   3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.7 HAZARDOUS MATERIAL IDENTIFICATION DEVICES

A. Standard: NFPA 704.

B. Material: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive; or mounting screws.
C. Size: Minimum 7-1/2 inches by 7-1/2 inches with 3-inch character height.
D. Content: Appropriate for refrigerant.

2.8 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 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 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 20, 21, 22, and 23 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, furnaces, heaters, stills, and absorption units.
   2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
   3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
   4. Fans, blowers, primary balancing dampers, and mixing boxes.
   5. Packaged HVAC central-station and zone-type units.
B. Install and permanently fasten equipment markers 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, furnaces, heaters, stills, and absorption units.
      e. Pumps, compressors, chillers, condensers, and similar motor-driven units.
      f. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
      g. Fans, blowers, primary balancing dampers, and mixing boxes.

h. Packaged HVAC central-station and zone-type units.
i. Tanks and pressure vessels.
j. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

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.
d. Brown: For energy-reclamation 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, furnaces, heaters, stills, and absorption units.
c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
e. Fans, blowers, primary balancing dampers, and mixing boxes.
f. Packaged HVAC central-station and zone-type units.
g. Tanks and pressure vessels.
h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

D. Install access panel markers with screws on equipment access panels.

E. Area Served: Equipment serving different areas of a building other than where the equipment is installed shall be permanently marked in a manner that, in addition to identifying the equipment as specified in this Section, also identifies the area it serves.

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, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

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.

C. Underground Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.

3.4 DUCT IDENTIFICATION

A. Identify ductwork with vinyl markers and flow direction arrows.
B. Locate markers at air handling units, each side of floor and wall penetrations, 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; 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: Minimum 1-1/2 inches, round or square.
      b. Hot Water: Minimum 1-1/2 inches, round or square.
      c. Fire Protection: Minimum 1-1/2 inches, round or square.
      d. Gas: Minimum 1-1/2 inches, round or square.

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 HAZARDOUS MATERIAL IDENTIFICATION DEVICE INSTALLATION

A. Mount to wall or door of room containing hazard. Indicate classification of refrigerant or other hazard.

3.9 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.10 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 20 0553

SECTION 20 0700 –
MECHANICAL 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”

2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section “Hanger and Supports” for thermal hanger shield inserts.
4. Division 22 Section “Plumbing Fixtures: for protective shielding guards.
5. Division 23 Section "Metal Ducts" for duct liners.

1.2 SUMMARY

A. This Section includes mechanical insulation for pipe, duct, and equipment.

1.3 DEFINITIONS

A. ASJ: All-service jacket.
B. FSK: Foil, scrim, kraft paper.
C. PSK: Polypropylene, scrim, kraft paper.
D. PVC: Polyvinyl Chloride.
E. SSL: Self-sealing lap.

1.4 INDOOR PIPING INSULATION SYSTEMS DESCRIPTION

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.
B. Hot Service Drains, All Pipe Sizes: Glass-Fiber or Mineral Wool, Preformed Pipe Insulation, Type I or II: 1 inch thick.
C. Hot Service Vents, All Pipe Sizes: Glass-Fiber or Mineral Wool, Preformed Pipe Insulation, Type I or II: 1 inch thick.

1.5 INDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION

A. Acceptable indoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.6 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION

A. Acceptable outdoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.7 EQUIPMENT INSULATION SYSTEMS DESCRIPTION

A. Acceptable equipment insulation materials and thicknesses are scheduled on the Drawings.

1.8 FIELD-APPLIED JACKETING SYSTEMS DESCRIPTION

A. Acceptable field-applied jacketing materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe specialty.
B. Steam Condensate Piping within Air Handling Units: Aluminum, Stucco Embossed: 0.016 inch thick.
C. Piping Within Energy Recovery Units: Type 304 Stainless Steel, Smooth: 0.010 inch thick. Seams and joints calked with chemically resistant sealer.
D. Steam Pressure Reducing Valves: Sound Barrier Jacketing: Smooth or stucco embossed.

1.9 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.10 QUALITY ASSURANCE

A. 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, 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.

B. Ductwork Maximum Temperature Limits: Based on ASTM C 411 test procedures.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Prior to installation, protect insulation from exposure to water and from physical damage. Prior to installation, store insulation in manufacturer's original packaging.

1.12 COORDINATION

A. Coordinate size and location of supports, hangers, and pre-insulated pipe shields/supports specified in Division 20 Section "Hangers and Supports."
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.

1.13 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, GENERAL REQUIREMENTS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
B. 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.
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. Adhesives used shall be fire resistant in their dry states and UL listed.

2.2 PIPE INSULATION MATERIALS

A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Aeroflex USA, Inc.; Aerocel Tube and Sheet.
   b. Armacell LLC; AP Armaflex.
   c. IK Insulation Group; K-Flex USA LLC; Insul-Tube and Insul-Sheet.

B. Glass-Fiber, Preformed Pipe Insulation, Type I:
1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Johns Manville; Micro-Lok.
   b. Knauf Insulation; 1000 Pipe Insulation.
   c. Manson Insulation Inc.; Alley-K.
   d. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

C. Mineral-Wool, Preformed Pipe Insulation, Type II:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Johns Manville.
      b. Owens Corning/Thermafiber.
      c. Rock Wool Manufacturing Company; Delta PC and PF.
   2. Type II, 1200 deg F Materials: Mineral wool fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied, or field-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article. Field-applied jacket requirements are specified in Part 2 "Field-Applied Jackets" Article.

2.3 DUCTWORK INSULATION MATERIALS

A. Blanket Insulation: 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 Part 2 "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite EQ.
      c. Knauf Insulation; Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap B.
      e. Owens Corning; All-Service Duct Wrap.

B. Board Insulation: 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 FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. CertainTeed Corp.; Commercial Board.
      b. Fibrex Insulations Inc.; FBX.
      c. Johns Manville; 800 Series Spin-Glas.
      d. Knauf Insulation; Insulation Board.
      e. Manson Insulation Inc.; AK Board.
      f. Owens Corning; Fiberglas 700 Series.

2.4 EQUIPMENT INSULATION MATERIALS

A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Aeroflex USA, Inc.; Aerocel Tube and Sheet.
      b. Armacell LLC; AP Armaflex.
      c. IK Insulation Group; K-Flex USA LLC; Insul-Tube and Insul-Sheet.

B. Board Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the products specified.

a. CertainTeed Corp.; Commercial Board.
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

C. Large Diameter Pipe and Tank Insulation: 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 Part 2 "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the products specified.
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.

2.5 INSULATING CEMENTS

A. 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 products specified.
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.

2.6 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it 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 products specified.
a. Aeroflex USA, Inc.; Aeroseal and Aeroseal LVOC.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.

C. ASJ Adhesive, and FSK and PVDC 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 products specified.
a. Childers Products, H.B. Fuller Company; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. Johns Manville Industrial Insulation; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

D. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the products specified.
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. Red Devil, Inc.; Celulon Ultra Clear.
e. Speedline Corporation; Speedline Vinyl Adhesive.

2.7 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Childers Products, H.B. Fuller Company; CP-35.
      b. Foster Products Corporation, H. B. Fuller Company; 30-90.
      c. Johns Manville Industrial Insulation; CB-50.
      d. Marathon Industries, Inc.; 590.
      e. Mon-Eco Industries, Inc.; 55-40.
      f. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
   5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Childers Products, H.B. Fuller Company; CP-10.
      b. Foster Products Corporation, H. B. Fuller Company; 35-00.
      c. Johns Manville Industrial Insulation; CB-05/15.
      d. Marathon Industries, Inc.; 550.
      e. Mon-Eco Industries, Inc.; 55-50.
      f. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 200 deg F.
   4. Solids Content: 63 percent by volume and 73 percent by weight.
   5. Color: White.

2.8 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Childers Products, H.B. Fuller Company; 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.
   5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Childers Products, H.B. Fuller Company; 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.

2.9 FACTORY-APPLIED JACKETS

A. Insulation systems 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.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   4. PSK Jacket: Metalized polypropylene, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
C. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
D. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as specified; roll stock ready for shop or field cutting and forming.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Airex Manufacturing, Inc.; E-Flex Guard.
      b. Johns Manville; Zeston and Ceel-Co.
      c. P.I.C. Plastics, Inc.; FG Series.
      d. Proto PVC Corporation; LoSmoke.
      e. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.
   4. Factory-fabricated tank heads and tank side panels.
E. PVC Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C, and including flexible glass fiber insulation inserts.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Airex Manufacturing, Inc.
      b. Johns Manville; Zeston and Ceel-Co.
      c. P.I.C. Plastics, Inc.; FG Series.
      d. Proto PVC Corporation; LoSmoke.
      e. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by manufacturer.
   3. Color: White.
   4. Factory-fabricated fitting covers:
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.
F. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. PABCO-Childers Metals; Johns Manville Industrial Insulation; Metal Jacketing Systems.
      b. 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 or factory cut and rolled to size.
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. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick Polysurlyn.
e. Factory-Fabricated Fitting Covers:
1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
2) Provide factory fabricated PVC tee covers, flange and union covers, beveled collars and valve covers.
3) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
a. Sheet and roll stock ready for shop or field sizing factory cut and rolled to size.
b. Material, finish, and thickness are indicated in field-applied jacket systems.
c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick Polysurlyn.
e. Factory-Fabricated Fitting Covers:
1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
2) Provide factory fabricated PVC tee covers, flange and union covers, beveled collars and valve covers.
3) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

G. Self-Adhesive Outdoor Jacket for Piping: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a fabric reinforced insulation cladding with natural aluminum stucco embossed facing.
1. Products: Subject to compliance with requirements, provide one of the products specified.
a. 3M VentureClad; 1579GCW-E.
b. Polyguard; Alumaguard.

H. Self-Adhesive Outdoor Jacket for Ductwork: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil facing.
1. Products: Subject to compliance with requirements, provide one of the products specified.
a. MFM Building Products Corp.; FlexClad-400.
b. Polyguard; Alumaguard.
c. 3M VentureClad.

2.11 REMOVABLE AND REUSABLE INSULATION COVERS

A. Flexible Style: Custom fabricated composite jackets for valves, flanges, and expansion joints consisting of 4 inches of high temperature fiberglass insulation compressed between Teflon impregnated fiberglass inner and outer facing stitched with fiberglass core Teflon thread, and secured with Velcro fasteners and double D-ring cinching. Service temperature range of minus 40 deg F to 500 deg F.
1. Fabricators:
a. Apex Energy & Environmental Products Inc.
b. 3i Supply Co.; K-Tex.
c. Valley Group of Companies.

B. Rigid Style: Custom fabricated composite jackets for valves, flanges, and expansion joints consisting of rigid foam insulation with silicone impregnated fiberglass outer facing stitched with fiberglass thread, and secured with Velcro fasteners and double D-ring cinching. Service temperature range of minus 40 deg F to 500 deg F.
   1. Fabricators:
      a. Valley Group of Companies.

2.12 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 728 Cold Seal ASJ or comparable products by one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division.
      b. 3M Venture Tape.
   2. Width: 3 inches.
   3. Thickness: 9 mils.
   4. Adhesion: 70 ounces force/inch in width.
   5. Elongation: 3 percent.
   6. Tensile Strength: 45 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 rubber or acrylic adhesive; complying with ASTM C 1136 and UL listed.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 491 FSK or 791 Cold Seal Acrylic FSK, or comparable products by one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division.
      b. 3M Venture Tape.
   2. Width: 3 inches.
   3. Thickness: 6 mils.
   4. Adhesion (Rubber Adhesive): 100 ounces force/inch in width.
   5. Adhesion (Acrylic Adhesive): 90 ounces force/inch in width.
   6. Elongation: 3 percent.
   7. Tensile Strength: 35 lbf/inch in width.
   8. 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. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 370 White PVC tape, or comparable products by one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division.
      b. 3M Venture Tape.
   2. Width: 2 inches.
   3. Thickness: 5 mils.
   4. Adhesion: 20 ounces force/inch in width.
   5. Elongation: 500 percent.
   6. Tensile Strength: 15 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 488 AWF rubber adhesive or 788 Cold Seal acrylic adhesive, or comparable products by one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division.
      b. 3M Venture Tape.
   2. Width: 3 inches.
   3. Thickness: 3.0 to 4.0 mils.

4. Adhesion (Rubber Adhesive): 90 ounces force/inch in width.
5. Adhesion (Acrylic Adhesive): 50 ounces force/inch in width.
6. Elongation: 3 percent.
7. Tensile Strength: 14 to 20 lbf/inch in width.

2.13 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. PABCO-Childers Metals; Johns Manville Industrial Insulation; Pab-Bands and Fabstraps.
      b. 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.
   4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

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 products specified.
         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 products specified.
         1) AGM Industries, Inc.; CWP-1.
         2) GEMCO; Cupped Head Weld Pin.
         3) Midwest Fasteners, Inc.; Cupped Head.
         4) Nelson Stud Welding; CHP.
   3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Products: Subject to compliance with requirements, provide one of the products specified.
         1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
         2) GEMCO; Perforated Base.
         3) Midwest Fasteners, Inc.; Spindle.
      b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
      d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. 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 products specified.
        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.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.
    1. Manufacturers:
        a. ACS Industries, Inc.
        b. C & F Wire.
        c. PABCO-Childers Metals; Johns Manville Industrial Insulation.
        d. RPR Products, Inc.

2.14 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.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

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 applies to insulation.

3.3 COMMON 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 the 4 o'clock or 8 o'clock position on 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 as recommended by insulation material manufacturer.
I. Install insulation with least number of joints practical.
J. For services with surface temperatures below ambient, install a continuous unbroken vapor barrier. 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 thermal hanger 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 thermal hanger 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 the 4 o'clock or 8 o'clock position on the pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 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. Where compression of insulation is possible, fabricate/install insulation per manufacturer's recommendations.
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 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.
   4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations that Are Not Fire Rated: Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations:
   1. Terminate ductwork insulation at angle closure of fire damper sleeves.
   2. Install pipe insulation continuously through penetrations of fire-rated walls and partitions.
      a. Firestopping is specified in Division 07 Section “Through-Penetration Firestop Systems.”

E. 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 angle closure of fire damper sleeves.
   2. Pipe: Install insulation continuously through floor penetrations.
      a. Seal penetrations through fire-rated assemblies according to Division 07 Section "Through-Penetration Firestop Systems."

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, 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 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 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.

E. Install removable and reusable insulation covers in accordance with fabricator’s instructions, and at the following locations:

1. At steam valves.
2. At valves, flanges, and expansion joints. Expansion joints shall have jacket installed in a manner to allow for replacing of joints without removing insulation cover.

3.6 FLEXIBLE ELASTOMERIC PIPE 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.

3.7 GLASS-FIBER AND MINERAL WOOL PIPE 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 PVC fitting covers when available.
   2. When PVC fitting covers are not available, install preformed pipe insulation to outer diameter of pipe flange:
      a. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
      b. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with fiberglass or mineral wool blanket insulation as specified for system.

3. 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 PVC fitting covers when available.
   2. When PVC fitting covers 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 PVC fitting covers when available.
   2. When PVC fitting covers 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.

3.8 DUCT AND PLENUM INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins.
   1. 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 over compress 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.
   2. 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.
   3. 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.
   4. 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.
   5. 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.

B. 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 over compress 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.

C. Flexible Elastomeric Thermal Insulation Installation for Ducts and Plenums: Install insulation over entire surface of ducts and plenums.
   1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
   2. Seal longitudinal seams and end joints.
   3. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with strips of same material used to insulate duct and following manufacturer’s installation instructions.

3.9 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. 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 over compress 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.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. 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.
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.
E. Where self-adhesive jackets are indicated, install according to manufacturer’s instructions and details on the drawings. Overlap seams arranged to shed water.

3.11 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system specified in Division 09 painting Sections.
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.

END OF SECTION 20 0700

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SECTION 20 2923
VARIABLE-FREQUENCY MOTOR 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 20 Section “Motors.”

1.2 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Requirements:
   1. Section 26 2419 "Motor-Control Centers" for VFCs installed in motor-control centers.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. DDC: Direct digital control.
C. EMI: Electromagnetic interference.
D. LED: Light-emitting diode.
E. NC: Normally closed.
F. NO: Normally open.
G. OCPD: Overcurrent protective device.
H. PID: Control action, proportional plus integral plus derivative.
I. RFI: Radio-frequency interference.
J. VFC: Variable-frequency motor controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.
   1. Include dimensions and finishes for VFCs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: For each VFC indicated.
   1. Include mounting 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.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Required working clearances and required area above and around VFCs.
   2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
   3. Show support locations, type of support, and weight on each support.
   4. Indicate field measurements.
B. Qualification Data: For testing agency.
C. Product Certificates: For each VFC from manufacturer.
D. Source quality-control reports.
E. Field quality-control reports.
F. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Division 1 include the following:
      a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
      b. Manufacturer's written instructions for setting field-adjustable overload relays.
      c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
      d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
      e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
      f. 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.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
B. Comply with NFPA70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.
B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.
B. Contractor shall troubleshoot issues within 24 hours of notification by the Owner. Warranty shall include all parts, labor, travel time and expenses.
C. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:
   1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
B. Application: variable torque.
C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
F. Unit Operating Requirements:
    1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFC input voltage rating.
    2. Input AC Voltage Unbalance: Not exceeding 5 percent.
    3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
    4. Minimum Efficiency: 96 percent at 60 Hz, full load.
    5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
    6. Minimum Short-Circuit Current (Withstand) Rating: Refer to the equipment schedules.
    7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
    8. Humidity Rating: Less than 95 percent (noncondensing).
    9. Altitude Rating: Not exceeding 3300 feet.
    10. Vibration Withstand: Comply with NEMA ICS 61800-2.
    11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
    12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
    13. Speed Regulation: Plus or minus 5 percent.
    14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
    15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
    1. Signal: Electrical.
I. Internal Adjustability Capabilities:
    1. Minimum Speed: 5 to 25 percent of maximum rpm.
    2. Maximum Speed: 80 to 100 percent of maximum rpm.
    3. Acceleration: 0.1 to 999.9 seconds.
    4. Deceleration: 0.1 to 999.9 seconds.
    5. Current Limit: 30 to minimum of 150 percent of maximum rating.
J. Self-Protection and Reliability Features:
    1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
    2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
    3. Under- and overvoltage trips.
    4. Inverter overcurrent trips.
    5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
    6. Critical frequency rejection, with three selectable, adjustable deadbands.
    7. Instantaneous line-to-line and line-to-ground overcurrent trips.
    8. Loss-of-phase protection.
    9. Reverse-phase protection.
    10. Short-circuit protection.
    11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
O. Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad-lockable, door-mounted handle mechanism.
    1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
    2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.

2.3 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
    1. Power on.
    2. Run.
    3. Overvoltage.
    4. Line fault.
    5. Overcurrent.
    6. External fault.
B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
    1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
    2. 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.
        a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
C. Historical Logging Information and Displays:
    1. Real-time clock with current time and date.
    2. Running log of total power versus time.
    3. Total run time.
    4. Fault log, maintaining last four faults with time and date stamp for each.
D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
    1. Output frequency (Hz).
    2. Motor speed (rpm).
    3. Motor status (running, stop, fault).
    4. Motor current (amperes).
    5. Motor torque (percent).
    6. Fault or alarming status (code).
    7. PID feedback signal (percent).
    8. DC-link voltage (V dc).
    9. Set point frequency (Hz).
    10. Motor output voltage (V ac).
E. Control Signal Interfaces:

1. Electric Input Signal Interface:
    a. A minimum of two programmable analog inputs: 0- to 10-V dc 4- to 20-mA dc.
    b. A minimum of six multifunction programmable digital inputs/outputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
    a. 0- to 10-V dc.
    b. 4- to 20-mA dc.
3. Output Signal Interface: A minimum of five programmable analog output signal(s) (0- to 10-V dc and 4- to 20-mA dc), which can be configured for any of the following:
    a. Output frequency (Hz).
    b. Output current (load).
    c. Motor torque (percent).
    d. Motor speed (rpm).
    e. Set point frequency (Hz).
4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    a. Motor running.
    b. Fault and warning indication (overtemperature or overcurrent).

F. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
1. Hardwired Points:
    a. Monitoring: On-off status.
    b. Control: On-off operation.
2. Communication Interface: BACnet/IP protocol.

2.4 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Provide 3% input AC line reactors.
B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.5 OPTIONAL FEATURES

A. Multiple-Motor Capability: Where scheduled, provide VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.
1. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.

B. Damper control circuit with end-of-travel feedback capability.
C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.
D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
E. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
F. Remote digital operator kit.
G. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.6 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Indoor Locations: Type 12.
2. Outdoor Locations: Type 4X.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated" when installed in spaces used as a return air pathway.

2.7 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
   1. Push Buttons: Covered.
   2. Pilot Lights: Push to test.
   3. Selector Switches: Rotary hand-off-auto.
   4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

E. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.8 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
   1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 26 0529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03.

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 supported equipment.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Install fuses in each fusible-switch VFC.
E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 26 2813 "Fuses."
F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
H. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices.
B. Bundle, train, and support wiring in enclosures.
C. Connect selector switches and other automatic-control devices where applicable.
1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control 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.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 26 0553 "Electrical Identification."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 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 tests and inspections with the assistance of a factory-authorized service representative.
D. Acceptance Testing Preparation:
1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives 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. Perform the infrared (thermographic) scan tests and inspections, in accordance with 260999 Electrical Testing.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

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.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

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SECTION 21 1100
FIRE-SUPPRESSION 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.

B. Provisions of Division 20 Section “Mechanical General Requirements” apply to this Section.

C. Related Sections include the following:

1. Division 10 Section "Fire-Protection Specialties" for cabinets and fire extinguishers.
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section "Hangers and Supports.”
4. Division 28 Section "Fire Alarm" for alarm devices not specified in this Section.
5. Division 33 Section "Water Distribution" for piping outside the building.

1.2 SUMMARY

A. This Section includes water-based fire-suppression systems inside the building.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. PE: Polyethylene plastic.

C. Underground Service-Entrance Piping: Underground service piping below the building.

D. Hose Connection: Valve with threaded outlet matching fire hose coupling thread for attaching fire hose.

E. Hose Station: Hose connection, fire hose rack, and fire hose.

F. Working Plans: Documents, including drawings, calculations, and material specifications prepared according to NFPA 13 and NFPA 14 for obtaining approval from authorities having jurisdiction.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. 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.

B. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from opened sprinklers.

1.5 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications, for bidding purposes, as follows:
   a. Building Service Areas: Ordinary Hazard, Group 1.
   b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
   c. General Storage Areas: Ordinary Hazard, Group 1.

d. Machine Shops: Ordinary Hazard, Group 2.
e. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
f. Office and Public Areas: Light Hazard.

3. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Light-Hazard Occupancy: 0.10 gpm/sq. ft. over 1500-sq. ft. area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
   c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm/sq. ft. over 1500-sq. ft. area.
   d. Special Occupancy Hazard: As determined by authorities having jurisdiction.
4. Maximum Protection Area per Sprinkler:
   a. Office Spaces: 225 sq. ft..
   b. Storage Areas: 130 sq. ft.
   c. Mechanical Equipment Rooms: 130 sq. ft.
   d. Electrical Equipment Rooms: 130 sq. ft.
   e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.

D. Water velocity in the piping system shall not exceed the following:
1. Underground mains: 16 ft./sec.
2. Aboveground mains: 20 ft./sec.
3. Sprinkler branch lines: 20 ft./sec.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: 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 signed and sealed by the qualified professional engineer responsible for their preparation.
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:
1. Domestic water piping.
2. Compressed air piping.
3. HVAC hydronic piping.
4. Items penetrating finished ceiling include the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
E. Qualification Data: For qualified Installer.
F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, and the Owner’s insurance underwriter including hydraulic calculations, if applicable.
1. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification number (SIN) or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.
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 13. Include "Contractor's Material and Test Certificate for Aboveground Piping"
J. Field quality-control reports.
K. Operation and Maintenance Data: For sprinkler specialties to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing fire-suppression 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 by a qualified professional engineer.
B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
C. The provisions and requirements of the NFPA and the Owner's insurance underwriter constitute mandatory minimum requirements for the work of this Section.
D. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."

1.8 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
B. Coordinate with ceiling installer to ensure proper grid type and installation for use with flexible sprinkler drops.

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. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, 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 on Project.

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 STANDARD-WEIGHT BLACK STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends, and with factory applied antimicrobial coating on inner wall of pipe.
   1. Cast-Iron Threaded Flanges: ASME B16.1.
   2. Malleable-Iron Threaded Fittings: ASME B16.3.
   3. Gray-Iron Threaded Fittings: ASME B16.4.
   4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
   5. Steel Threaded Couplings: ASTM A 865.
B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, and with factory applied antimicrobial coating on inner wall of pipe.
   1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
   2. Steel Flanges and Flanged Fittings: ASME B16.5.

C. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut- or roll- grooved ends, and with factory applied antimicrobial coating on inner wall of pipe.
   1. Grooved-Joint Piping Systems:
      a. Manufacturers:
         1) Anvil International, Inc.; Model 7401.
         2) Tyco Fire & Building Products; Grinnell Mechanical Products; Model 577 or 772.
         3) Victaulic Co. of America; Style 005 or 009.
      b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
      c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.3 BACKFLOW PREVENTION DEVICES

A. Double-Check, Detector-Assembly Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. FEBCO; a Division of Watts Water Technologies, Inc.
      c. Watts Water Technologies, Inc.; Ames Fire & Waterworks.
      d. Watts Water Technologies, Inc.; Watts Regulator Co.
      e. Zurn Plumbing Products Group; Wilkins Div.
   2. Standard: ASSE 1048 and FMG approved or UL listed.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
   5. Body: Cast-iron or ductile-iron, with interior lining complying with AWWA C550 or that is FDA approved.
   6. End Connections: Flanged.
   7. Configuration: Designed for horizontal, straight through flow.
   8. Accessories:
      a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
      b. Bypass: With displacement-type water meter, shutoff valves, and double-check backflow prevention device.

2.4 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.
B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
   1. Manufacturers:
      a. Tyco Fire & Building Products LP.
      b. Fire-End and Croker Corp.
      c. Viking Corp.
      d. Victaulic Co. of America.
C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
   1. Manufacturers:
      a. Elkhart Brass Mfg. Co., Inc.
D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

1. Manufacturers:
    a. AGF Manufacturing Co.
    b. Tyco Fire & Building Products LP.
    c. G/J Innovations, Inc.
    d. Triple R Specialty of Ajax, Inc.

E. Flexible Sprinkler Drop Fittings:
1. Manufacturers:
    a. Victaulic Co. of America; AquaFlex Sprinkler Fittings; AH-2 with AB1 Bracket Assembly.
    b. FlexHead Industries, Inc.
2. Description: UL listed and FMG approved flexible hose for connection to sprinkler, and with bracket for connection to commercial ceiling grid.
3. Standard: UL 2443.
4. Pressure Rating: 175 psig minimum.
5. Size: Same as connected piping, for sprinkler.

F. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.5 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.
B. Ball Valves: Comply with UL 1091, except with ball instead of disc.
1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
3. NPS 3: Ductile-iron body with grooved ends.
4. Manufacturers:
    a. NIBCO.
    b. Victaulic Co. of America.

C. Butterfly Valves: UL 1091.
1. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
    a. Manufacturers:
        1) McWane, Inc.; Kennedy Valve Div.
        2) Mueller Company.
        3) NIBCO.
        4) Tyco Fire & Building Products.
        5) Victaulic Co. of America.

D. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
1. Manufacturers:
    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Tyco Fire & Building Products.
    d. Hammond Valve.
    e. McWane, Inc.; Kennedy Valve Div.
    f. Mueller Company.
    g. NIBCO.
    h. Crane Co.; Crane Valve Group; Stockham Valves.
    i. Victaulic Co. of America.
    j. Watts Water Technologies, Inc.; Watts Regulator Co.

E. Gate Valves: UL 262, OS&Y type.
1. NPS 2 and Smaller: Bronze body with threaded ends.
    a. Manufacturers:
        1) Crane Co.; Crane Valve Group; Crane Valves.
        2) Hammond Valve.

3) NIBCO.
2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
a. Manufacturers:
1) McWane, Inc.; Clow Valve Co.
2) Crane Co.; Crane Valve Group; Crane Valves.
3) Crane Co.; Crane Valve Group; Jenkins Valves.
4) Hammond Valve.
5) Milwaukee Valve Company.
6) Mueller Company.
7) NIBCO.

F. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
1. Indicator: Visual.
2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
a. Manufacturers:
1) Milwaukee Valve Company.
2) NIBCO.
3) Victaulic Co. of America.
3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
a. Manufacturers:
1) Tyco Fire & Building Products LP.
2) McWane, Inc.; Kennedy Valve Div.
3) Milwaukee Valve Company.
4) NIBCO.
5) Victaulic Co. of America.

2.6 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.
B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.
C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.
D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.7 ALARM CHECK VALVES

A. General Requirements:
1. Standard: UL listed or FMG approved.
2. Pressure Rating:
a. Standard-Pressure Valves: 175 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.
B. Manufacturers:
1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products.
3. Viking Corp.
4. Victaulic Co. of America.
C. Description: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets

for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
1. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

2.8 DRY PIPE VALVES

A. General Requirements:
1. Standard: UL listed or FMG approved.
2. Pressure Rating:
a. Standard-Pressure Valves: 175 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Manufacturers:
1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products.
3. Viking Corp.
4. Victaulic Co. of America.

C. Description: UL 260, differential type; with bronze seat with O-ring seals, single-hinge pin, and latch design. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
1. Air-Pressure Maintenance Device: UL 260, automatic device to maintain correct air pressure in piping. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig maximum inlet pressure.
a. Manufacturers:
1) Reliable Automatic Sprinkler Co., Inc.
2) Tyco Fire & Building Products.
3) Viking Corp.
2. Air Compressor: UL 753, fractional horsepower, 120-V ac, 60 Hz, single phase.
a. Manufacturers:
1) Tyco Fire & Building Products.
2) Reliable Automatic Sprinkler Co., Inc.
3) Viking Corp.

2.9 AUTOMATIC (BALL DRIP) DRAIN VALVES

A. General:
1. Standard: UL 1726.
2. Pressure Rating: 175 psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

B. Manufacturer:
1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products.

2.10 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Manufacturers:
1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products.
3. Victaulic Co. of America.

4. Viking Corp.

C. Automatic Sprinklers:
   1. With heat-responsive glass bulb element complying with the following:
      a. UL 199, for nonresidential applications.
      b. UL 1767, for early-suppression, fast-response applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for 165 deg F "Ordinary" and 286 deg F “High” temperature classification rating, unless otherwise indicated or required by application.

E. Sprinkler types, features, and options as follows:
   1. Concealed ceiling sprinklers, including cover plate.
   2. Extended-coverage sprinklers.
   3. Pendent sprinklers.
   4. Quick-response sprinklers.
   5. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. Sprinkler guards listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.11 FIRE DEPARTMENT CONNECTIONS

A. Manufacturers:
   1. Elkhart Brass Mfg. Co., Inc.
   2. Potter-Roemer; Fire-Protection Div.

B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."
   1. Type: Exposed, projecting, with two inlets and round escutcheon plate.
   2. Finish: Rough chrome-plated.

2.12 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
   1. Manufacturers:
      a. Potter Electric Signal Company.
      b. System Sensor.

C. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
   1. Manufacturers:
      a. Potter Electric Signal Company.
      b. System Sensor.

2.13 PRESSURE GAGES

A. Manufacturers:
   1. AMETEK, Inc.; U.S. Gauge.
   2. Ashcroft Inc.
   3. Marsh Bellofram.
   4. Viking Corp.

5. Weiss Instruments, Inc.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.
   1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
   2. Air System Piping: Include caption "AIR" or "AIR/WATER" on dial face.

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 Part 1 "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 EARTHWORK

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.3 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 thicknesses, 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.

3.4 PIPING APPLICATIONS, GENERAL

A. Flanges, flanged fittings, unions, nipples, grooved-joint couplings, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

B. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints; or grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

C. Underground Service-Entrance Piping: Ductile-iron, push-on or mechanical-joint pipe and fittings and restrained joints.[**Include corrosion-protective encasement.**]

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Wet-Pipe Sprinklers: Use the following:

Pipe Type	1 ½" & Smaller	2"	2 ½" – 3 ½"	4"	5" – 6"
Standard weight steel, threaded fittings	YES	YES	YES	YES	NO
Standard weight steel, grooved fittings	NO	NO	YES	YES	YES
Standard weight steel, welded fittings	NO	YES	YES	YES	YES
Galv. standard weight steel, threaded fittings	YES	YES	YES	YES	YES
Galv. standard weight steel, lock-ing fittings	NO	NO	NO	NO	NO
Galv. standard weight steel, grooved fittings	NO	NO	YES	YES	YES

B. Dry-Pipe Sprinklers: Use the following:

Pipe Type	1 ½" & Smaller	2"	2 ½" - 4"
Galv. standard weight steel, threaded fittings	YES	YES	YES
Galv. standard weight steel, grooved fittings	NO	NO	YES

3.6 VALVE APPLICATIONS

A. The following requirements apply:
   1. Listed Fire-Protection Valves: UL listed or FMG approved for applications where required by NFPA 13.
      a. Shutoff Duty: Use ball, butterfly, or gate valves.
   2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13.
      a. Shutoff Duty: Use ball, butterfly, or gate valves.

3.7 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
C. 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.
D. Use of saddle style tees is not acceptable.
E. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
   1. All grooved couplings, fittings, gaskets, valves, and specialties shall be the product of a single manufacturer.
   2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
   3. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.

3.8 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 33 Section "Water Distribution" for exterior piping.
B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

3.9 PIPING INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping installation.
B. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
C. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
D. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

E. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
F. Install sprinkler piping with drains for complete system drainage.
G. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
H. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
I. Install alarm devices in piping systems.
J. Hangers and Supports: Comply with NFPA 13 for hanger materials.
    1. Install standpipe system piping according to NFPA 14.
    2. Install sprinkler system piping according to NFPA 13, except use of “C” clamps, or beam clamps of “C” pattern, or any modification thereof, is prohibited.
    3. Refer to Division 20 Section “Hangers and Supports” for additional requirements.
K. 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 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.
L. Drain dry-pipe sprinkler piping.
M. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices.
N. Fill wet-pipe sprinkler system piping with water.

3.10 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty 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. Valves for Wall-Type Fire Hydrants: Install nonrising-stem gate valve in water-supply pipe.
D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
E. Specialty Valves:
    1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.
    2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
        a. Air-Pressure Maintenance Devices for Dry-Pipe Systems: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
        b. Install air compressor and compressed-air supply piping.

3.11 SPRINKLER APPLICATIONS

A. Use the following sprinkler types:
    1. Rooms without Ceilings: Upright sprinklers.
    2. Rooms with Suspended Ceilings: Concealed sprinklers.
    3. Sprinkler Finishes:
        a. Upright, Pendent, and Sidewall Sprinklers: Painted in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate in areas with standard lay-in ceilings, in areas with custom ceiling system provided factory painted cover plate in a custom color/finish as selected by the architect.

4. Sprinkler Guards: For exposed sprinkler heads subject to damage.

3.12 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.

B. Install sprinklers into flexible sprinkler drop fittings and install into bracket on ceiling grid. Install according to manufacturer's instructions and NFPA, State, and local guidelines. Ceiling grid must meet requirements of ASTM C 635 and C 636, coordinate with ceiling installer.

3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connections in vertical wall.

B. Install ball drip valve at each check valve for fire department connection.

3.14 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping.

C. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

D. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

E. Connect compressed-air supply to dry-pipe sprinkler piping.

F. Connect air compressor to the following piping and wiring:

1. Pressure gages and controls.
2. Electrical power system.
3. Fire alarm devices, including low-pressure alarm.

G. Electrical Connections: Power wiring and fire alarm wiring are specified in Division 26.

H. Connect alarm devices to fire alarm.

I. Ground equipment according to Division 26 Section "Grounding and Bonding."

J. Connect wiring according to Division 26 Section "Conductors and Cables."

K. 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.

3.15 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and in Division 20 Section "Mechanical Identification."

3.16 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. 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. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
5. Verify that equipment hose threads are same as local fire department equipment.

6. Test each backflow prevention device according to authorities having jurisdiction and the device's reference standard.

B. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
C. Verify that air compressors and their accessories are installed and operate correctly.
D. Verify that specified tests of piping are complete.
E. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
F. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
G. Verify that potable-water supplies have correct types of backflow preventers.
H. Pressurize and check dry-pipe sprinkler piping air-pressure maintenance devices and air compressors.
I. Energize circuits to electrical equipment and devices.
J. Start and run air compressors.
K. Adjust operating controls and pressure settings.
L. Coordinate with fire alarm tests. Operate as required.
M. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.17 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.
B. Remove and replace sprinklers with paint other than factory finish.
C. Protect sprinklers from damage until Substantial Completion.

3.18 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

END OF SECTION 21 1100

SECTION 22 0523
GENERAL DUTY VALVES 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.

B. Related Sections include the following:
   1. Division 20 Section "Mechanical Identification" for valve tags and charts.
   2. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
   3. Division 22 piping Sections for specialty valves applicable to those Sections only.
   4. Division 23 Section “General-Duty Valves for HVAC” for HVAC valves.
   5. Division 23 Section "Temperature Controls" for control valves and actuators.
   6. Division 33 piping Sections for general-duty and specialty valves for site construction piping.

1.2 SUMMARY

A. This Section includes valves for general plumbing applications. Refer to piping Sections for specialty valve applications.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. NBR: Acrylonitrile-butadiene rubber.
   4. NRS: Nonrising stem.

5. OS&Y: Outside screw and yoke.
6. PTFE: Polytetrafluoroethylene plastic.
7. RPTFE: Reinforced polytetrafluoroethylene plastic.
8. SWP: Steam working pressure.
9. TFE: Tetrafluoroethylene plastic.
10. WOG: Water, oil, and gas.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
   1. Certification that products for use in potable water systems comply with NSF 61 and NSF 372.

1.5 QUALITY ASSURANCE

A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
C. NSF Compliance: NSF 61 and NSF 372 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. Set butterfly valves closed or slightly open.
   6. 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 VALVES, GENERAL

A. Isolation valves are scheduled on the Drawings. For other general plumbing valve applications, use the following:
   1. Throttling Service: Angle, ball, butterfly, or globe valves.
   2. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.
B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
D. For valves not indicated in the Application Schedules, select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water, heating hot water, steam, and steam condensate services.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted unless otherwise noted. Wetted surfaces of valves contacted by consumable water shall contain not more than 0.25 percent weighted average lead content.
1. Exceptions:
a. Valves in pumped sanitary systems.
b. Valves in pumped storm systems.
c. Drain valves.
d. Valves in general air or vacuum systems.
e. Valves in irrigation systems.
f. Valves in non-potable water systems.
g. Valves in other plumbing systems not intended for human consumption.

F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

G. Valve Actuators:
1. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Lever Handle: For quarter-turn valves NPS 6 and smaller.

H. Extended Valve Stems: On insulated valves.

I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

J. Valve Grooved Ends: AWWA C606.

K. Solder Joint: With sockets according to ASME B16.18.
1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.

L. Threaded: With threads according to ASME B1.20.1.

M. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; by Conbraco Industries, Inc.; Series 70LF-140/240.
b. Hammond Valve.
c. Milwaukee Valve Company; Model UPBA100S/150S.
d. NIBCO INC.; Models S-580-70-66-LF/T-580-70-66-LF.
e. Watts Water Technologies, Inc.

2.3 GENERAL SERVICE BUTTERFLY VALVES

A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

1. Full lug, and grooved valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange.
2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

B. Lug-Style (Single-Flange) Size NPS 2-1/2 through NPS 12, 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat (liner).
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD145.
      b. Bray International, Inc.
      c. DeZurik.
      d. Forum Energy Technologies; ABZ Valve.
      e. Hammond Valve.
      f. Milwaukee Valve Company.
      g. NIBCO INC.; LD-2000-3/5.
      h. Pentair Valves & Controls; Keystone.
      i. Tyco Flow Control; Grinnell Flow Control.
      j. Watts Water Technologies.

2.4 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 125, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.; Model 162T-LF and 163T-LF (61YLF Series).
      b. Milwaukee Valve Company; Model UP509/UP1509.
      c. NIBCO INC.; Models S-413-B-LF or T-413-B-LF.
      d. Watts Water Technologies; LFCVY/LFCVYS.

2.5 IRON SWING CHECK VALVES

A. Iron Swing Check Valves, General: MSS SP-71.

B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.; Model 910F.
      b. Crane Co.; Crane Valves.
      c. Crane Co.; Stockham Div.
      d. Hammond Valve; IR1124-HI.
      e. Milwaukee Valve Company; Model F-2974.
      f. NIBCO INC.; Model F-918-B.
      g. Watts Water Technologies.

C. Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends; nonasbestos, synthetic-fiber gaskets; rubber seats; and having 250-psig CWP Rating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Mueller Co.

b. NIBCO, INC.; Model G-917-W.
c. Tyco Fire & Building Products; Grinnell Mechanical Products.
d. Victaulic Co. of America.

2.6 LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic TFE Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; by Conbraco Industries, Inc.; Model CBV-LF (61LF Series).
b. Hammond Valve; UP943 and UP947.
c. Milwaukee Valve Company; UP548T and UP1548T.
d. NIBCO INC.; Model S-480-Y-LF and T-480-Y-LF.
e. Watts Water Technologies; LF600.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 250 psig.
c. Body Design: Vertical flow.
d. Body Material: Lead free brass or bronze.
e. Ends: Threaded or Solder.
f. Disc: PTFE, or TFE.

2.7 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK VALVES

A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.
B. Class 125, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 200 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO INC.; Model W-910-B-LF.
b. Mueller Steam Specialty.
c. Milwaukee Valve Company.
d. Hammond Valve.
C. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 200 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO INC.; Model F-910-B-LF.
b. Mueller Steam Specialty.
c. Milwaukee Valve Company.
d. Hammond Valve.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Bronze ball valve as specified in this Section. Lead free construction is not required.
2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 SOURCE QUALITY CONTROL

A. Identification: Factory label or color coding to identify lead free valves.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.
B. 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.
C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
D. Examine threads on valve and mating pipe for form and cleanliness.
E. 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.
F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
C. Locate valves for easy access and provide separate support where necessary.
D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.
E. Install valves in position to allow full stem movement.
F. Install chainwheel operators on valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor elevation.
G. 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 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 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 22 0523

SECTION 22 1116
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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods” for materials and methods common to mechanical piping systems.
   3. Division 20 Section “Hangers and Supports.”
   4. Division 20 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
   5. Division 22 Section “Plumbing Valves” for general duty plumbing valves.
   6. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.2 SUMMARY

A. This Section includes domestic water piping and water meters inside the building.

1.3 PERFORMANCE REQUIREMENTS

A. Where not indicated on the Drawings, provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1.4 SYSTEMS DESCRIPTION

A. Potable and non-potable domestic water piping system materials are scheduled on the Drawing.
B. Refer to Application Schedules on the Drawings for valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
   2. Drain Duty: Hose-end drain valves.
   3. Isolation Valves at Domestic Water Meters: Gate Valves, NPS 2 and Smaller: Class 150, bronze.
   4. Isolation Valves at Domestic Water Meters: Gate Valves, NPS 2-1/2 and Larger: Class 125, OS&Y, bronze-mounted cast iron.
C. Transition and special fittings with pressure ratings at least equal to piping rating may be used unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings and water meters.
B. Water Samples: Specified in Part 3 "Cleaning" Article.
C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Fire-suppression-water piping.
   2. Domestic water piping.
   3. Compressed air piping.
   4. HVAC hydronic piping.
D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
   2. Do not proceed with interruption of water service without Owner's written permission.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

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. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K, 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. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
   3. 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.

B. Hard Copper Tube: ASTM B 88, Type L, 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. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
   3. 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.

C. Grooved-Joint Systems:
   1. Manufacturers:
      a. Anvil International, Inc.; Gruvlok Manufacturing; Model 7401.
      b. Tyco Fire & Building Products; Grinnell Mechanical Products; Model 672.
      c. Victaulic Company; Style 606 and Style 607.
   2. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.
   3. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

2.4 VALVES

A. General-duty plumbing valves; and drain valves are specified in Division 22 Section "Plumbing Valves."

B. Balancing valves are specified in Division 22 Section "Domestic Water Piping Specialties."

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earthwork."

3.2 PIPING SYSTEM INSTALLATION

A. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Install 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 20 Section "Basic Mechanical Materials and Methods."

C. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 20 Section "Basic Mechanical Materials and Methods."
D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 20 Section "Meters and Gages," and strainers are specified in Division 22 Section "Domestic Water Piping Specialties."
E. 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.
F. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
   1. Install hose-end drain valves at low points in water mains, risers, and branches.
   2. Install stop-and-waste drain valves where indicated.
G. 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. Calibrated balancing valves are specified in Division 22 Section "Domestic Water Piping Specialties."
H. Install domestic water piping level without pitch and plumb.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support devices are specified in Division 20 Section "Hangers and Supports." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. 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: MSS Type 49, spring cushion rolls, if indicated.
   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 20 Section "Hangers and Supports."
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
E. Install hangers for drawn-temper copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60-inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
F. Install supports for vertical copper tubing every 10 feet.
G. Soft copper tube: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.
H. Alternate support for copper tubing NPS 3/4 and smaller: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.
I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect domestic water piping to distribution side of water meter with shutoff valve.
C. Connect domestic water piping to existing domestic water distribution piping. Use dielectric fitting if connection dissimilar metals. Refer to Application Schedule on the Drawings and Division 20 Section “Basic Mechanical Materials and Methods” for dielectric fittings.
D. Install piping adjacent to equipment and machines to allow service and maintenance.
E. Connect domestic water piping to the following:
    1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
    2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
    3. 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 and larger.

3.6 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:
    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 24 hours 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 test or inspection, make required corrections and arrange for reinspection.
    4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
B. Test domestic water piping as follows:
    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 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 150 psig. 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 required corrective action.

3.7 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 plugs used 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.

3.8 CLEANING AND DISINFECTION

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
B. Clean and disinfect potable domestic water piping as follows:
    1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
    2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as 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 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 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.
C. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION 22 1116

SECTION 22 1119
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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 20 Section "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.
   4. Division 22 Section "Domestic Water Piping" for water meters.
   5. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

C. Flow Reports and Settings: For calibrated balancing valves.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
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."
   3. Comply with NSF 372, “Drinking Water System Components – Lead Content” for components with wetted surfaces in contact with potable water.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; Conbraco Industries, Inc.
      b. Watts Water Technologies, Inc.; Watts Regulator Co.
   2. Standard: ASSE 1001.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   4. Body: Bronze.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: Chrome plated.
B. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; Conbraco Industries, Inc.
      b. MIFAB, Inc.
      c. Watts Water Technologies, Inc.; Watts Regulator Co.
      d. Woodford Manufacturing Company.
   2. Standard: ASSE 1011.
   3. Body: Bronze or brass, nonremovable, with manual drain.
   4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
   5. Finish: Chrome or nickel plated.
C. Pressure Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; Conbraco Industries, Inc.
      b. Watts Water Technologies, Inc.; Ames Fire & Waterworks.
      c. Watts Water Technologies, Inc.; Watts Regulator Co.
   2. Standard: ASSE 1020.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
   5. Accessories:
      a. Valves: Ball type, on inlet and outlet.
D. Laboratory-Faucet Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; Conbraco Industries, Inc.

b. Watts Water Technologies, Inc.; Watts Regulator Co.
c. Woodford Manufacturing Company.
2. Standard: ASSE 1035.
3. Size: NPS 1/4 or NPS 3/8 matching faucet size.
4. Body: Bronze.
5. End Connections: Threaded.
6. Finish: Chrome plated.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; Conbraco Industries, Inc.
b. Watts Water Technologies, Inc.; Watts Regulator Co.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Body: Bronze.
5. End Connections: Union, solder joint.
6. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Ames Fire & Waterworks; a Watts Brand; Silver Bullet Series Model 4000 SS (size 2-1/2" and larger).
b. Watts Water Technologies, Inc.; Watts Regulator Co Model 009. (size 2" and smaller).
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Size and Capacities: As scheduled on the drawings.
6. Body: Bronze for NPS 2 and smaller; 300 Series stainless steel for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
c. Y-Pattern strainer and soft-seated check valve.

C. Double-Check Backflow-Prevention Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Ames Fire & Waterworks; a Watts Brand; Silver Bullet Series.
b. Apollo Valves; Conbraco Industries, Inc.
c. Watts Water Technologies, Inc.; Watts Regulator Co.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Size and Capacities: As scheduled on the drawings.
6. Body: Bronze for NPS 2 and smaller; 300 Series stainless steel for NPS 2-1/2 and larger.

7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Bell & Gossett; Xylem Inc.
    b. Taco, Inc.
    c. Watts Water Technologies, Inc.; Watts Regulator Co.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size and Capacities: As scheduled on the drawings.
5. Body: Bronze for NPS 2 and smaller; cast iron for NPS 2-1/2 and NPS 3.
6. Valves for Booster Heater Water Supply: Include integral bypass.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.4 BALANCING VALVES

A. Calibrated Balancing Valves NPS 1/2:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Armstrong International, Inc.
    b. Armstrong Pumps, Inc.
    c. Apollo Valves; by Conbraco Industries, Inc.
    d. Bell & Gossett; Xylem Inc.
    e. Flo Fab Inc.
    f. Flow Design Inc.
    g. Griswold Controls.
    h. NIBCO INC.
    i. IMI Indoor Climate; Tour & Andersson.
    j. Taco, Inc.
    k. Watts Water Technologies, Inc.; Watts Regulator Co.
2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Dezincification resistant brass, or bronze.
4. Minimum Flow Rate: 0.3 gpm.

B. Calibrated Balancing Valves NPS 3/4 to NPS 2:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Armstrong International, Inc.
    b. Armstrong Pumps, Inc.
    c. Apollo Valves; by Conbraco Industries, Inc.
    d. Bell & Gossett; Xylem Inc.
    e. Flo Fab Inc.
    f. Flow Design Inc.
    g. Griswold Controls.
    h. NIBCO INC.
    i. IMI Indoor Climate; Tour & Andersson.

j. Taco, Inc.
k. Watts Water Technologies, Inc.; Watts Regulator Co.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Dezincification resistant brass, or bronze.
4. Size: Same as connected piping, but not larger than NPS 2.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; Conbraco Industries, Inc.; Model MVD (34D Series).
b. Bradley Corporation.
c. Lawler Manufacturing Company, Inc.
d. Leonard Valve Company; Series 170-LF and 270-LF.
e. Watts Water Technologies, Inc.; Powers Division; Hydroguard Series LFe480, LFG480, and LFLM495.
f. Watts Water Technologies, Inc.; Watts Regulator Co.
g. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: 1/2-inch union or 3/8-inch compression; with integral check valves.
7. Accessories: Adjustable temperature-control knob.
8. Outlet Temperature Range: Adjustable from 85 deg F to 120 deg F. Set at 105 deg F.
9. Minimum Flow Rate: 0.5 gpm**.**
10. Valve Finish: Chrome plated.

B. Photographic-Process, Thermostatic, Water-Mixing-Valve Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Leonard Valve Company.
b. Armstrong International, Inc. (RADA).
c. Lawler Manufacturing Company, Inc.
d. Watts Water Technologies, Inc.; Powers Division.
e. Symmons Industries, Inc.
2. Description: Thermostatically controlled water mixing valve made for precise, process-water temperature control.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze with corrosion-resistant interior components.
5. Connections: Threaded inlets and outlet.
6. Accessories: Manual temperature control, check stops and strainers on hot- and cold-water supplies, thermometer, shutoff valve, and adjustable, temperature-control handle.
7. Cabinet: Factory-fabricated, stainless steel, for surface mounting; with controls and thermometer mounted on front.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
1. Manufacturers:
a. Apollo Valves; Conbraco Industries, Inc.
b. Keckley.
c. Metraflex.

d. Mueller Steam Specialty.
e. NIBCO, Inc.
f. Spence.
g. SSI Equipment, Inc.
h. Watts Water Technologies, Inc.
i. Yarway.

2. CWP: 200 psig minimum, unless otherwise indicated.
3. SWP: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
5. End Connections: Threaded or soldered for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Screen: Stainless steel with round perforations, unless otherwise indicated.
7. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.033 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
   c. Strainers NPS 5 and Larger: 0.045 inch.
8. Drain: Pipe plug.

2.7 OUTLET BOXES

A. Clothes Washer Outlet Boxes:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Guy Gray Manufacturing Co., Inc.
   2. Mounting: Recessed.
   3. Material and Finish: Enameled- or epoxy-painted-steel or Stainless-steel box and faceplate.
   4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
   5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
   6. Drain: NPS 1-1/2 standpipe and P-trap for direct waste connection to drainage piping.

B. Icemaker Outlet Boxes:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company.
      b. LSP Products Group, Inc.
   2. Mounting: Recessed.
   3. Material and Finish: Enameled- or epoxy-painted-steel or Stainless-steel box and faceplate.
   4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
   5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.8 HOSE BIBBS

A. Hose Bibbs:
   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 threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.

6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: 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 integral wall flange with each chrome- or nickel-plated hose bibb.

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
   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.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Water Technologies, Inc.; Watts Regulator co.
      f. Woodford Manufacturing Company.
      g. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.21.3M for self-draining wall hydrants.
   3. Pressure Rating: 125 psig.
   4. Operation: Loose key.
   5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
   6. Inlet: NPS 3/4 or NPS 1.
   7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
   8. Box: Deep, flush mounting with cover.
   9. Box and Cover Finish: Polished nickel bronze or chrome plated.
   10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
   11. Nozzle and Wall-Plate Finish: Chrome plated.
   12. Operating Keys(s): Two with each wall hydrant.

2.10 WATER HAMMER ARRESTERS

A. Water Hammer Arresters (Copper Tube Type):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MIFAB, Inc.
      b. PPP Inc.
      c. Sioux Chief Manufacturing Company, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Watts Water Technologies, Inc.; Watts Regulator Co.
   2. Standard: ASSE 1010 or PDI-WH 201.
   3. Type: Copper tube with piston.
   4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.
B. Water Hammer Arresters (Metal Bellows Type):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Josam Company.
c. MIFAB, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Precharged stainless steel bellows.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.11 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:
1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.12 DOMESTIC WATER CARTRIDGE FILTERS

A. Off-Floor Cartridge Filters:
1. Manufacturers:
a. Culligan International Company.
b. Harmsco Filtration Products.
c. Osmonics, Inc.; Hytrex Filters Div.
d. Parker Hannifin Corporation; Process Filtration Div.
e. Siemens Water Technologies.
f. Water Equipment Technologies (WET); Xylem Inc.
g. Watts Premier.

2. Description: Simplex, in-line housing with replaceable element for removing suspended particles from water.
a. Housing: Corrosion resistant; designed to separate feedwater from filtrate and to direct feedwater through water filter element; with element support.
1) Pipe Connections: Threaded according to ASME B1.20.1.
2) Support: Wall bracket.
b. Element: Replaceable; of shape to fit housing.

3. Capacity and Characteristics:
a. Refer to Schedule on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" 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.
   4. Install strainer and soft-seated check valve upstream of backflow preventer. Exception: Fire protection backflow preventers.
C. Install balancing valves in locations where they can easily be adjusted.
D. Install temperature-actuated water mixing valves with strainers, and check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers and water regulators if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.
E. Install Y-pattern strainers for water where indicated and on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
F. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
G. Install water hammer arresters in water piping according to PDI-WH 201.
H. Install air vents at high points of water piping.[Install drain piping and discharge onto floor drain.]

3.2 DOMESTIC WATER CARTRIDGE-FILTER INSTALLATION

A. Install cartridge filters 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.
B. Attach wall brackets for off-floor, wall-mounting, cartridge filter to vertical surface. Attach housing(s), and base if any, to wall bracket.
C. Install housings for off-floor, in-line, cartridge filters in piping.
D. Install isolation valves on inlet and outlet piping of each water filter.
E. Install pressure gages on inlet and outlet piping of each water filter. Pressure gages are specified in Division 20 Section "Meters and Gages."
   1. Exception: Water filtration equipment with factory-installed pressure gages at locations indicated.
F. Install filter elements in cartridges after completion of flushing and cleaning.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping and specialties.

3.4 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. Double-check backflow-prevention assemblies.
   5. Carbonated-beverage-machine backflow preventers.
   6. Dual-check-valve backflow preventers.
   7. Water pressure-reducing valves.

8. Calibrated balancing valves.
9. Primary, thermostatic, water mixing valves.
10. Manifold, thermostatic, water-mixing-valve assemblies.
11. Photographic-process, thermostatic, water-mixing-valve assemblies.
12. Primary water tempering valves.
13. Outlet boxes.
14. Hose stations.
15. Supply-type, trap-seal primer valves.
16. Trap-seal primer systems.

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 20 Section "Mechanical Identification."

3.5 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.

3.6 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves as follows:
   1. Set calibrated balancing valves at calculated presettings.
   2. Measure flow at all stations and adjust where necessary.
   3. Record settings and mark balancing devices.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 1119

SECTION 22 1123
DOMESTIC WATER CIRCULATION 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.
B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 20 Section “Pipe Flexible Connectors, Expansion Fittings and Loops.”

1.2 SUBMITTALS

A. Product Data: For each type and size of domestic water 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 domestic water pumps to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water 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 an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
C. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.
E. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.4 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.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of pumps that fail in materials or workmanship within 60 months from date of project acceptance. Contractor shall troubleshoot issues within 24 hours of notification by the Owner. Warranty shall include all parts, labor, travel time and expenses.
B. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warranty issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

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 (SMALL)

A. Manufacturers:
   1. Bell & Gossett; Xylem Inc.; Series PL.
   2. Taco, Inc. Series 1400.
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; and designed for installation with pump and motor shafts mounted horizontally.
   1. Pump Construction: All bronze.
      a. Casing: Radially split, bronze, with threaded companion-flange connections.
      b. Impeller: Glass-reinforced corrosion-resistant material; keyed to shaft.
      c. Shaft: High-strength alloy steel.
      d. Seal: Mechanical, carbon/silicon carbide seal.
      e. Bearings: Permanently oil-lubricated type.
   2. Motor-Single speed, with oil-lubricated bearings, unless otherwise indicated; and directly mounted to pump casing. Comply with requirements in Division 20 Section “Motors.”
C. Capacities and Characteristics: Refer to Schedule on Drawings.

2.3 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
   1. Manufacturers:
      a. Honeywell International, Inc.
      b. Square D.

c. White-Rodgers Div.; Emerson Electric Co.
2. Type: Water-immersion sensor, for installation in hot-water circulation piping.
3. Range: 65 to 200 deg F.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V, ac.
7. Settings: Start pump at 105 deg F and stop pump at 120 deg F.

2.4 FLEXIBLE CONNECTORS

A. Refer to Division 20 Section “Pipe Flexible Connectors, Expansion Fittings and Loops.”

2.5 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 of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.
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. Do not use pump motors as a support point.
D. Install centrifugal pumps with motor and pump shafts horizontal.
E. Install continuous-thread hanger rods and of sufficient size to support pump weight. Vibration isolation devices are specified in Division 20 Section "Mechanical Vibration Controls." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 20 Section "Hangers and Supports."

3.3 CONTROL INSTALLATION

A. Install immersion-type thermostats in hot-water return piping.
B. Install timers where indicated on Drawings.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to pumps to allow service and maintenance.
C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."
1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
a. Separately coupled, in-line centrifugal pumps.
b. Separately coupled, horizontally mounted, in-line centrifugal pumps.
c. Close-coupled, horizontally mounted, in-line centrifugal pumps.
d. Close-coupled, vertically mounted, in-line centrifugal pumps.

2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 20 Section "Valves" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.
3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 20 Section "Meters and Gages" for pressure gages and gage connectors.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."
E. Connect wiring according to Division 26 Section "Conductors and Cables."
F. Connect thermostats to pumps that they control.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions.
   1. Check piping connections for tightness.
   2. Clean strainers on suction piping.
   3. Set thermostats for automatic starting and stopping operation of pumps.
   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.
   8. Adjust temperature settings on thermostats.
   9. Adjust timer settings.

END OF SECTION 22 1123

SECTION 22 1316
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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements”.
   2. Division 20 Section “Basic Mechanical Materials and Methods”.
   3. Division 22 Section “Drainage Piping Specialties”.
   4. Division 22 Section "Sewage Pumps."

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.
B. EPDM: Ethylene-propylene-diene terpolymer rubber.
C. LLDPE: Linear, low-density polyethylene plastic.
D. NBR: Acrylonitrile-butadiene rubber.
E. PE: Polyethylene plastic.
F. PVC: Polyvinyl chloride plastic.
G. TPE: Thermoplastic elastomer.

1.3 SYSTEMS DESCRIPTIONS

A. Sanitary waste and vent piping system materials are scheduled on the Drawing.

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).
C. 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.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste 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 Construction Manager no fewer than two days in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste service without Construction Manager's written permission.

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 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.
B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers:
      a. ANACO-Husky; McWane Plumbing Group.
      b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).
      c. IDEAL-TRIDON.
      d. Mission Rubber Company; a division of MCP Industries, Inc.
      e. Tyler Pipe; McWane Plumbing Group.
   2. Standards: CISPI 310.
   3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 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, 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.

2.4 SPECIALTY PIPE FITTINGS

A. 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.

B. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      a. ANACO.

C. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Dresser, Inc.; DMD Div.
      c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
      d. JCM Industries, Inc.
      e. Smith-Blair, Inc.
      f. Viking Johnson.
   2. Center-Sleeve Material: Manufacturer's standard.
   3. Gasket Material: Natural or synthetic rubber.
   4. Metal Component Finish: Corrosion-resistant coating or material.

D. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
   1. Manufacturers:
      a. SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Comply with requirements in Division 31 Section “Earth Moving” for excavating, trenching, and backfilling.

3.2 PIPING SYSTEM 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 coordination drawings.

B. Sanitary sewer piping outside the building is specified in Division 22 Section "Sanitary Sewerage."

C. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

F. 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 20 Section "Basic Mechanical Materials and Methods."

G. 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."

H. 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.

I. 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.

J. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
   2. Horizontal Sanitary Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
   3. Vent Piping: 1/8-inch per foot down toward vertical fixture vent or toward vent stack.

K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

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.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, nonpressure transition couplings.
   3. In Aboveground Force Main Piping: Fitting-type transition couplings.
   4. In Underground Force Main Piping:
      a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
      b. NPS 2 and Larger: Pressure transition couplings.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 20 Section "Valves."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 and smaller.
   2. Install gate valve or butterfly valve for piping NPS 2-1/2 and larger.

C. 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 20 Section "Hangers and Supports." 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 20 Section "Hangers and Supports."
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 and NPS 8: 60 inches with 3/4-inch rod.
   5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
F. Install supports for vertical cast-iron soil piping every 15 feet.
G. 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.
H. Install supports for vertical copper tubing every 10 feet.
I. 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 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.
D. Connect force-main piping to the following:
   1. Sanitary Sewer: To exterior force main or sanitary manhole.
   2. Sewage Pumps: To sewage pump discharge.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 20 Section "Mechanical Identification."

3.9 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 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 150 psig, 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.

3.10 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 22 1316

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SECTION 22 1319
DRAINAGE 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 22 Section "Plumbing Fixtures" for hair interceptors.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.
B. FRP: Fiberglass-reinforced plastic.
C. HDPE: High-density polyethylene plastic.
D. PE: Polyethylene plastic.
E. PP: Polypropylene plastic.
F. PUR: Polyurethane plastic.
G. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.
B. Shop Drawings:
C. Field quality-control test reports.

D. Operation and Maintenance Data: For drainage piping specialties to include in operation and maintenance manuals.

1.4 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 an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary and storm piping specialty components.

1.5 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CAST-IRON CLEANOUTS

A. Size: Cleanouts shall be same nominal size as the pipe they serve up to 4 inches. For pipes larger than 4 inches nominal size, minimum size of cleanout shall be 4 inches.
B. Exposed Cast-Iron Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Zurn Plumbing Products Group; Specification Drainage Operation.
      b. Watts Drainage Products Inc.
      c. Tyler Pipe; Wade Div.
      d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; 4510 Series.
      e. MIFAB, Inc.; C1460.
      f. Josam Company; Josam Div.; Series 58910.
   2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
   4. Closure: Countersunk or raised-head, brass or bronze plug with tapered threads.
C. Cast-Iron Floor Cleanouts (On-Grade Interior Floor Areas):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Zurn Plumbing Products Group; Specification Drainage Operation.
      b. Watts Drainage Products Inc.
      c. Tyler Pipe; Wade Div.
      d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 4023S-F.
      e. Sioux Chief Manufacturing Company, Inc.
      f. MIFAB, Inc.; C1220-R.
      g. Josam Company; Josam Div.
   2. Standard: ASME A112.36.2M.
   3. Type: Adjustable housing.
   4. Body or Ferrule: Cast iron.
   5. Clamping Device: Not required.
   6. Outlet Connection: Spigot.
   7. Closure: Brass, bronze, or plastic plug with tapered threads.
   8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
   9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated cover in service areas, and recessed cover to accept floor finish material in finished floor areas.

10. Frame and Cover Shape: Round.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

D. Cast–Iron Floor Cleanouts (Not-On-Grade Interior Floor Areas):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Zurn Plumbing Products Group; Specification Drainage Operation.
   b. Watts Drainage Products Inc.
   c. Tyler Pipe; Wade Div.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 4333C.
   e. Sioux Chief Manufacturing Company, Inc.
   f. MIFAB, Inc.; C-1100-C-R-34.
   g. Josam Company; Josam Div.
2. Standard: ASME A112.36.2M.
3. Type: Adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Required.
6. Outlet Connection: Spigot.
7. Closure: Brass, bronze, or plastic plug with tapered threads.
8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated cover in service areas, and recessed cover to accept floor finish material in finished floor areas.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

E. Cast-Iron Wall Cleanouts (Finished Wall Areas):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Zurn Plumbing Products Group; Specification Drainage Operation.
   b. Watts Drainage Products Inc.
   c. Tyler Pipe; Wade Div.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. MIFAB,Inc.; C1460-RD.
   f. Josam Company; Josam Div.; Model 58790-20.
2. Standard: ASME A112.36.2M. Include wall access.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded bronze or brass plug with tapered threads.
5. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains (Toilet Rooms, Labs, and Janitor's Closet) FD-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Zurn Plumbing Products Group; Specification Drainage Operation.
   b. Watts Drainage Products Inc.
   c. Tyler Pipe; Wade Div.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 2005Y-A.

e. Sioux Chief Manufacturing Company, Inc.; Finish Line Adjustable Drainage System.
f. MIFAB, Inc.
g. Josam Company; Josam Div.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Enamel.
9. Top or Strainer Material: Nickel bronze.
10. Top of Body and Strainer Finish: Nickel bronze.
11. Top Shape: Round, with vandal proof screws.
12. Dimensions of Top or Strainer: 7 inch diameter.
13. Top Loading Classification: Light Duty.
14. Funnel: Not required.
15. Inlet Fitting: Gray iron, with spigot outlet.
16. Trap-Seal Protection Device: Required.

B. Cast-Iron Floor Drains (Mechanical Rooms, Electrical Rooms, and Penthouses) FD-2:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Zurn Plumbing Products Group; Specification Drainage Operation.
b. Watts Drainage Products Inc.
c. Tyler Pipe; Wade Div.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 2142.
e. MIFAB, Inc.
f. Josam Company; Josam Div.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Enamel.
9. Sediment Bucket: 3-3/4 inches deep, slotted sediment bucket with lift bar.
10. Top or Strainer Material: Cast-iron.
11. Top Shape: Round.
12. Dimensions of Top or Strainer: 11-1/2 inch diameter tractor grate, 29 square inches of free area.
13. Top Loading Classification: Heavy Duty.
14. Funnel: Not required.
15. Outlet Fitting: Gray iron, with spigot outlet.
16. Trap-Seal Protection Device: Required.

C. Large Capacity Floor Drains FD-3:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Zurn Plumbing Products Group; Specification Drainage Operation.
b. Watts Drainage Products Inc.
c. Tyler Pipe; Wade Div.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 2450-SSB.
e. MIFAB, Inc.
f. Josam Company; Josam Div.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Fabricated steel.
5. Seepage Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Galvanized coating.
9. Sediment Bucket: Perforated stainless steel sediment bucket with lift bar.
10. Top or Strainer Material: Cast iron.
11. Top of Body and Strainer Finish: Gray iron.
12. Top Shape: Rectangular.
13. Dimensions of Top or Strainer: 12-3/4 inch by 10-3/4 inch. Provide partial grate where required to accept equipment drains.
14. Top Loading Classification: Heavy Duty.
15. Outlet Connection: Spigot outlet.
16. Trap-Seal Protection Device: Required.

2.3 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ayrlett, LLC.
      b. Durgo, Inc.
      c. Oatey.
      d. ProSet Systems Inc.
      e. RectorSeal.
      f. Studor, Inc.
   2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
   3. Housing: Plastic.
   4. Operation: Mechanical sealing diaphragm.
   5. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Durgo, Inc.
      b. Oatey.
      c. Studor, Inc.
   2. Standard: ASSE 1050 for vent stacks.
   3. Housing: Plastic.
   4. Operation: Mechanical sealing diaphragm.
   5. Size: Same as connected stack vent or vent stack.

C. Wall Box:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Durgo, Inc.
      b. Oatey.
      c. RectorSeal.
      d. Studor, Inc.
   2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
   3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

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 consisting of metal flashing collar and skirt extending at least 10 inches from pipe, with boot reinforcement and counterflashing fitting.
   1. Open-Top Vent Cap: Without cap.

2.5 TRAP SEAL PROTECTION DEVICES

A. Barrier Type Trap Seal Protection Devices:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Smith, Jay R. Mfg. Co.; Quad Close Trap Seal Device Fig. 2692.
      b. SureSeal Manufacturing; Inline Floor Drain Trap Sealer.
   2. Standard: ASSE 1072-2007.
   3. Sealing Element: Neoprene rubber or chemically resistant elastomer.
   4. Size: 2 inch, 3 inch, 3-1/2 inch, or 4 inch.
   5. Gravity Drain Outlet Connection: Compression fit sealing gasket 80 durometer.

2.6 ROOF DRAINS

A. Metal Roof Drains RD-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Zurn Plumbing Products Group; Specification Drainage Operation.
      b. Watts Drainage Products Inc.
      c. Tyler Pipe; Wade Div.
      d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 1015/1074.
      e. MIFAB, Inc.
      f. Josam Company; Josam Div.
   2. Standard: ASME A112.6.4
   3. Pattern: Roof drain.
   4. Body Material: Cast iron.
   5. Dimensions of Body: Minimum 10 inch diameter body.
   6. Combination Flashing Ring and Gravel Stop: Required.
   7. Flow-Control Weirs: Not required.
   8. Outlet: Bottom.
   9. Dome Material: Cast iron, or ductile iron.
   10. Extension Collars: Required.
   11. Underdeck Clamp: Required.
   12. Sump Receiver: Required.
   13. Standpipe: 2 inches high where overflow drains are indicated.

2.7 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Hub Outlets:
   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. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Sleeve Flashing Device:
1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend **2 inches** above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

D. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Conductor Nozzles DNZ-1:
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.; Model 1770-NB-BS.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.; RD-940-83.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Description: Bronze body with threaded inlet, bronze wall flange with mounting holes, and bird screen.
3. Size: Same as connected conductor.

2.8 FLASHING MATERIALS

A. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
B. Fasteners: Metal compatible with material and substrate being fastened.
C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
D. Solder: ASTM B 32, lead-free alloy.
E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" 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. Use NPS 4 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 for piping NPS 4 and smaller and 100 feet 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 or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
        b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
        c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch 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 fixture air-admittance valves on fixture drain piping.
G. Install stack air-admittance valves at top of stack vent and vent stack piping.
H. Install air-admittance-valve wall boxes recessed in wall.
I. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
J. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
K. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
    1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
    2. Position roof drains for easy access and maintenance.
L. Assemble open drain fittings and install with top of hub 2 inches above floor.
M. Install deep-seal traps on floor drains and other waste outlets, if indicated.
N. Install floor-drain, trap-seal primer fittings on floor drains that require trap-seal primer connection.
O. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
P. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
Q. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
R. Install wood-blocking reinforcement for wall-mounting-type specialties.
S. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
T. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20, 21, 22, and 23 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. 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, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
B. Set flashing on floors and roofs in solid coating of bituminous cement.
C. Secure flashing into sleeve and specialty clamping ring or device.
D. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
F. 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 22 1319

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SECTION 22 1413
STORM 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 22 Section “Drainage Piping Specialties.”
   4. Division 22 Section "Sump Pumps."

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

E. TPE: Thermoplastic elastomer.

1.3 SYSTEMS DESCRIPTIONS

A. Storm drainage piping system materials are scheduled on the Drawing.

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).
C. 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 and "NSF-sewer" for plastic sewer piping.
D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

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 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.
B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers:
      a. ANACO-Husky; McWane Plumbing Group.
      b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).
      c. IDEAL-TRIDON.
      d. Mission Rubber Company; a division of MCP Industries, Inc.
      e. Tyler Pipe; McWane Plumbing Group.
   2. Standards: CISPI 310.
   3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 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, Type L, 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.

2.4 SPECIAL PIPE FITTINGS

A. 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.
B. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Dresser, Inc.; DMD Div.

c. EBAA Iron Sales, Inc.
d. Ford Meter Box Company, Inc. (The); Pipe Products Div.
e. JCM Industries, Inc.
f. Romac Industries, Inc.
g. Smith-Blair, Inc.
h. Viking Johnson.

2. Center-Sleeve Material: Manufacturer's standard.
3. Gasket Material: Natural or synthetic rubber.
4. Metal Component Finish: Corrosion-resistant coating or material.

C. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
1. Manufacturers:
a. SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING SYSTEM INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Drainage."
B. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Drainage Piping Specialties."
D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
E. 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."
F. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. 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.
G. Lay buried building drain 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.
H. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
1. Building Storm Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
2. Horizontal Storm-Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.

I. Install force mains at elevations indicated.
J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 20 Section "Valves."
B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 20 Section "Hangers and Supports." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. 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 20 Section "Hangers and Supports."
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.
   6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
F. Install supports for vertical cast-iron soil piping every 15 feet.
G. 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.
H. Install supports for vertical copper tubing every 10 feet.
I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
C. Connect storm drainage piping to roof drains and storm drainage specialties.
D. Connect force-main piping to the following:

1. Storm Sewer: To exterior force main or storm manhole.
2. Sump Pumps: To sump pump discharge.

3.7 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.
   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 storm drainage 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 storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Test Procedure: Test storm drainage piping 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. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   5. 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 150 psig, 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.

3.8 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 22 1413

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SECTION 22 1429
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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 22 Section “Sewage Pumps” for applications in sanitary drainage systems.

1.2 SUMMARY

A. This Section includes sump pumps and accessories, inside the building, for building storm drainage systems.

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, 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 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 an NRTL 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.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of pumps that fail in materials or workmanship within 60 months from date of project acceptance. Contractor shall troubleshoot issues within 24 hours of notification by the Owner. Warranty shall include all parts, labor, travel time and expenses.
B. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

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 SELF PRIMING TRASH PUMPS

A. Manufacturers:
   1. EBARA Fluid Handling; Series EFQ.
   2. Gorman-Rupp Pumps.
   3. Goulds Water Technology; a Xylem Brand.
   4. Hydromatic Pump; Pentair Ltd.
   5. Myers Pump; Pentair Ltd.
B. Description: Factory-assembled and -tested, centrifugal, self-priming end-suction sump pumps. Horizontal, electrically driven, direct coupled, pumps.
   1. Pump Arrangement: Duplex.
   2. Casing: Cast iron, with flanged inlet and discharge connections, and carbon steel wear plate.
   3. Impeller: Ductile iron; statically and dynamically balanced two-vane, semi-open solids handling design; keyed and secured to shaft.
   4. Pump Shaft: 4140 Alloy steel shaft with ball-type thrust bearings.
   5. Pump and Motor Shaft Coupling: Direct, complete with OSHA approved guards.
   6. Check Valve: Reinforced neoprene, flap type.
C. Pump Discharge Piping: Refer to Division 22 Section “Storm Drainage Piping.”
D. Basin or Pit Cover: Cast iron or steel with bituminous coating and strong enough to support pumps, motors, and controls. See Part 2 Article for requirements.
E. Cover Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.

F. Motor: TEFC, single speed; grease-lubricated ball bearings. Comply with requirements in Division 20 Section "Motors" with built-in thermal-overload protection appropriate for motor size and duty.
G. Controls:
1. Mount controls in NEMA 250, Type 4X enclosure. Controls shall include: Fused disconnect switches and combination magnetic starters with overload protection for each phase to protect against single phasing. Three phase units shall include control transformer and control circuit fuse.
a. Minimum SCCR according to UL 508 shall be as indicated on the Drawings or 22,000 A**,** whichever is greater.
2. Furnish an automatic alternator with manual on-off switch to change sequence of pump operation on the completion of each pump cycle.
a. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
1) 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.
2) NEMA KS 1, heavy-duty, nonfusible switch.
3) UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
3. Mount three position, hand-off-auto, selector switches and magnetic starter manual reset push-buttons on the control panel door for manual operation and resetting of the magnetic starters.
4. Station shall be furnished with four, single pole, normally-open NON-mercury mechanical float switches with 20 ft. cords, clamps, cord grips, and fasteners for pump off/lead pump on/lag pump on/high-water-alarm operation. The high-water-alarm switch shall be mounted as indicated on the Drawings. System shall be complete with cover mounting bracket. (1-inch diameter support pole by Contractor.)
5. Provide high water alarm switch, complete with actuating mechanism for operation on an electric circuit other than the motor circuit. The switch shall be designed to operate indicated alarm device(s) and one set of spare contacts whenever a predetermined high-water level is reached in the sump. Provide alarm pilot light and alarm bell with silence switch. Mount controls on pedestal on the sump cover plate.

2.3 PACKAGED DRAINAGE PUMP UNITS

A. Submersible Units: Factory-assembled and -tested, single-stage, centrifugal, end-suction, automatic-operation, submersible, drainage pump unit.
1. Manufacturers:
a. Crane Pumps and Systems; Barnes.
b. Goulds Pumps; Xylem Inc.
c. Grundfos Pumps Corp.
d. Little Giant Pump Co.
e. Zoeller Company.
2. Pump Body: Metal.
3. Impeller: Brass.
4. Pump Seals: Mechanical type.
5. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection. Comply with requirements in Division 20 Section "Motors."
6. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches, with grounding plug and cable-sealing assembly for connection at pump.
7. Control: Motor-mounted float switch.

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. Install sump pumps according to applicable requirements in Hydraulic Institute HI 1.4.
B. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.
C. Set submersible sump pumps on pit floor.
D. Support piping so weight of piping is not supported by pumps.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Section "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. Connect storm drainage piping to pumps. Install discharge piping equal to pump discharge connection size. If pump discharge connection size is different from storm drainage piping size, provide transition from pump discharge piping size to storm drainage piping size. Refer to Division 22 Section “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 20 Section "Valves" for general-duty valves for drainage piping.
D. Ground equipment according to Division 26 Section "Grounding and Bonding."
E. Connect wiring according to Division 26 Section "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.
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.

END OF SECTION 22 1429

SECTION 22 1513
GENERAL-SERVICE COMPRESSED-AIR 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. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 20 Section "Meters and Gages" for thermometers and pressure gages.
   4. Division 22 Section "General-Service Compressed-Air Equipment" for compressed-air equipment and accessories.

1.2 SUMMARY

A. This Section includes piping and related specialties for general-service (shop) compressed-air systems operating at 200 psig and less.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.

C. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 125 and 200 psig.

D. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 125 psig and less.

E. NBR: Acrylonitrile-butadiene rubber.

1.4 SYSTEMS DESCRIPTIONS

A. Low-Pressure Compressed-Air Piping between Air Compressors and Receivers: Use the following piping materials for each size range:
   1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded malleable-iron fittings; and threaded joints.
   2. NPS 2-1/2 and Larger: Schedule 40, black-steel pipe; flanged.
B. Low-Pressure Compressed-Air Distribution Piping: Use the following piping materials for each size range:
   1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded malleable-iron fittings; and threaded joints.
   2. NPS 2-1/2 and Larger: Schedule 40, black-steel pipe; flanged.
C. High-Pressure Compressed-Air Piping between Air Compressors and Receivers: Use the following piping materials for each size range:
   1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded malleable-iron fittings; and threaded joints.
   2. NPS 2-1/2 and Larger: Schedule 40, black-steel pipe; flanged.
D. High-Pressure Compressed-Air Distribution Piping: Use the following piping materials for each size range:
   1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded malleable-iron fittings; and threaded joints.
   2. NPS 2-1/2 and Larger: Schedule 40, black-steel pipe; flanged.
E. Valves:
   1. Refer to Division 20 Section "Valves" for general duty valves for compressed air service. Use metal valves, unless otherwise indicated.
   2. Equipment Isolation NPS 2 and Smaller: Safety-exhaust ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Pipes, tubes, and fittings.
   2. Safety valves.
   3. Pressure regulators.
   4. Filters.
   5. Automatic drain valves.
   6. Quick couplings.
   7. Hose assemblies.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For general-service compressed-air systems. Include relationship to other services that serve same work area.

1.7 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.
B. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.
C. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 1 "Systems Descriptions" Article for applications of pipe, tube, fittings, valves, and joining materials.

2.2 PIPES, TUBES, AND FITTINGS

A. Black, Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B.

1. Steel Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.

B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. Flexible Pipe Connectors: Refer to Division 20 Section “Pipe Flexible Connectors, Expansion Fittings and Loops.”

2.3 JOINING MATERIALS

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

2.4 VALVES

A. General Duty Valves: Comply with requirements specified in Division 20 Section "Valves."

2.5 SPECIALTY VALVES

A. Safety-Exhaust, Bronze Ball Valves: Two-piece bronze stem and chrome-plated bronze ball, having exhaust vent opening for pneumatic applications, locking handle, threaded ends, and 600-psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.; Apollo Div.; 7K-100-27.
      b. DynaQuip Controls.
      c. Hammond Valve.
      d. Milwaukee Valve Company.
      e. NIBCO INC.; Model T-585-70-SV.
      f. Watts Water Technologies, Inc.

2.6 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet safety valve for compressed-air service.
   1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Emerson Process Management; Fisher Controls.
      b. IMI Norgren.
      c. Parker-Hannifin Corporation.
   2. Type: Pilot operated.

C. Air-Line Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Emerson Process Management; Fisher Controls.
      b. IMI Norgren.
      c. Parker-Hannifin Corporation.
   2. Type: Diaphragm or pilot operated.

D. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters in sizes and ratings indicated. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock.
E. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded.
F. Automatic Drain Valves: Corrosion-resistant metal body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.
G. Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Aeroquip by Eaton.
        b. Hansen Coupling by Eaton.
        c. Parker Hannifin Corporation; Fluid Connectors Group; Quick Coupling Div.
        d. Snap-Tite; Division of Parker-Hannifin
    2. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
        a. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
H. Hose Assemblies: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig minimum working pressure, unless otherwise indicated.
    1. Hose: Reinforced double-wire-braid, CR-covered hose for compressed-air service.
    2. Hose Clamps: Stainless-steel clamps or bands.
    3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with serrated ends for connecting two sections of hose.
    4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with serrated ends for connecting two sections of hose.
I. Hose-Reel Assemblies: Individual, retractable hose-reel units with steel face plates, steel mounting boxes, factory- or field-fabricated mounting brackets, and service hoses with adjustable ball stop and service connections matching hoses. Include 50 feet of delivery hose, 2 feet of connecting hose, and quick disconnect. Hose and fittings rated for minimum 125 psig service.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1.) Reelcraft Industries.
        2.) Hannay Reels Inc.
J. Air Blow Gun:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Legacy; AG7-X.
        b. GuardAir Corporation.
        c. Parker Hannifin Corporation.
    2. Steel construction with tapered tip design.
    3. Thumb operated.
    4. Rubber tip for painted surfaces.
    5. Suitable for pressures up to 100-psig .

PART 3 - EXECUTION

3.1 PIPING SYSTEM INSTALLATION

A. Drawings, plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
B. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping installation.
C. Install air and drain piping with 1 percent slope downward in direction of airflow.
D. Install eccentric reducers where piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
E. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
F. Install flexible pipe connector on each connection to air compressors.
G. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver; install according to Division 20 Section "Meters and Gages."

3.2 VALVE INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping and valve installation.
B. Install metal general-duty valves according to Division 20 Section "Valves."
C. Install shutoff valve at each connection to and from general-service compressed-air specialties, equipment, and accessories. Install strainer if indicated.
D. Install check valves to maintain correct direction of fluid flow to and from compressed-air piping specialties and equipment.
E. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
F. Install automatic drain valves on intercoolers, aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.
G. Install safety valves where recommended by specialty manufacturers.

3.3 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
B. 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.
C. Joining of Dissimilar Metal Piping: Use dielectric fittings. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for dielectric fitting types.

3.4 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 20 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
    1. Vertical Piping: MSS Type 8 or 42, clamps.
    2. 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 20 Section "Hangers and Supports."
C. Support horizontal piping within 12 inches of each fitting and coupling.
D. Support vertical piping and tubing at base and at each floor.
E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
F. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.
2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.
3. NPS 1-1/2: 12 feet with 3/8-inch rod.
4. NPS 2: 13 feet with 3/8-inch rod.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to specialties and equipment to allow service and maintenance.
C. Connect piping to air compressors, accessories, and specialties with shutoff valve and union or flanged connection.
D. Use metal general-service compressed-air piping between air compressors and air receivers. Use of plastic piping for this application is prohibited.
E. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.
F. Specialty and Equipment Flanged Connections: Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube.

3.6 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping systems. Refer to Division 20 Section "Mechanical Identification" for labeling and identification materials.

3.7 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
1. Test and adjust piping safety controls. Replace damaged and malfunctioning safety controls.
2. Piping Leak Tests: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
a. Repair leaks and retest until no leaks exist.
3. Report results in writing.

END OF SECTION 22 1513

SECTION 22 1519
GENERAL-SERVICE COMPRESSED-AIR 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 20 Section “Motors.”
   4. Division 22 Section "General-Service Compressed-Air Piping" for compressed-air piping, valves, and related specialties.

1.2 SUMMARY

A. This Section includes general-service (shop) compressed-air equipment and related accessories.

1.3 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.

B. Standard Air: Free air at 68 deg F and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm.
C. PAO: Polyalphaolefin.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following compressed-air equipment:
   1. Air compressors, including receivers and intake filters.
   2. Aftercoolers.
   3. Compressed-air dryers.
   4. Compressed-air filter assemblies.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings:
   1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
   2. 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.
   3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   4. Wiring Diagrams: Power, signal, and control wiring.
B. Product Certificates: Certificates of shop inspection and data report for receiver tanks as required by ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
C. Qualification Data: For Installer.

1.6 CLOSEOUT SUBMITTALS

A. Startup service reports.
B. Operation and Maintenance Data: For the following compressed-air equipment and accessories to include in emergency, operation, and maintenance manuals:
   1. Air compressors.
   2. Compressed-air dryers.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative of compressed-air equipment manufacturer for both installation and maintenance of units required for this Project.
B. Product Options: Drawings indicate size, profiles, and dimensional requirements of compressed-air equipment 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 an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
D. ASME Compliance: Fabricate and label receiver tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
E. Comply with NFPA 70, "National Electrical Code."

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for concrete bases. Refer to Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete requirements.

1.9 WARRANTY

A. Warranty period shall be for two years, beginning with receipt of Owners written acceptance of equipment (after debugging, acceptance checking and final acceptance but not less than 40 hours of uninterrupted operation).
B. Two-year warranty includes coverage for complete compressor package as manufactured and delivered to site including materials and labor.
C. Contractor shall troubleshoot issues within 24 hours of notification by the Owner.
D. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

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. Air-Compressor Inlet-Filter Element Units: Equal to 10 percent of amount installed, but no fewer than two units.
    2. Maintenance Kit: Include kit having 3 bearings, 1 oil filter, 1 air/oil separator element, one 5 gallon container of lubricant.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where 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 DIRECT DRIVEN, OIL-LUBRICATED, SINGLE-STAGE, VARIABLE SPEED, AIR COOLED, ROTARY SCREW AIR COMPRESSOR (AC-1).

A. Variable Speed Oil-Flooded, Screw Air Compressors:
    1. Manufacturers:
        a. Atlas Copco Compressors, Inc. Model GA.
        b. CompAir; a Brand of Ingersoll-Rand, Inc.
        c. Gardner Denver; a Brand of Ingersoll-Rand, Inc.
        d. Ingersoll-Rand; a Brand of Ingersoll-Rand, Inc.
        e. Kaeser Compressors, Inc.
        f. Quincy Compressor.
        g. Sullair Corporation.
    1. Number of Compressors: One.
    2. General
        a. The rotary screw air compressor shall be capable of producing and delivering 100% of the required air demand as specified at standard operating conditions.
        b. The compressor shall be designed and supplied as a complete package with all necessary equipment, including but not limited to the following components: inlet filter, air compression element, drive motor, aftercooler with integral moisture separator, oil cooler, cooling fan, variable speed drive, microprocessor regulation and control system. All components shall be mounted on a common solid base frame and fully enclosed with a sound attenuating enclosure.

c. The compressor package shall be rated to operate in ambient conditions from 32°F to 115°F.
d. The compressor shall be able to operate at any speed in between its minimum and maximum speed.
e. The compressor must not idle when the demand decreases below the minimum flow of the compressor.
f. The units shall be manufactured by a qualified manufacturer who has been manufacturing air compressors for at least ten (10) years.
g. The compressor manufacturer shall be certified under ISO 9001 / 9002 quality standards and ISO 14001 environmental standards.
h. The manufacturer must participate in the Compressed Air & Gas Institute (CAGI) Performance Verification program.

3. Compressor Enclosure
   a. The compressor shall be enclosed in a steel sound attenuating canopy with removable panels.
   b. The sound attenuating material shall be flame retardant polyurethane foam.
   c. The compressor canopy should be of a hot-cold canopy design. This design should isolate all heat producing components (motor, electronics, compressor element) from all other components.
4. Noise Levels
   a. The compressor package shall not exceed 67 dB(A) when measured in the free field conditions at one meter in accordance with the CAGI-Pneurop Test Code.
5. Compressor Element
   a. The compression profile shall be of the asymmetric profile design with four lobes on the male rotor and six lobes on the female rotor.
   b. The male and female rotors shall have the same diameter.
   c. The compressor element must be vertically oriented in the canopy.
   d. The oil for the lubrication of the compressor element must be pre-heated by the cooling jacket of the motor.
   e. The element housing shall be of cast iron construction.
6. Drive Motor
   a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section "Motors."
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
7. Drive Arrangement
   a. The drive arrangement shall be a direct driven design.
   b. The drive system shall be fully enclosed to protect against dirt and dust intrusion.
8. Cooling System
   a. The compressor package shall be fitted with an aluminum, air-cooled, oil cooler and aftercooler.
   b. The cooling system shall include an axial fan.
9. Moisture Separator
   a. The compressor shall be equipped with a labyrinth style moisture separator integrated in the discharge side of the after-cooler.
10. Water Drain
    a. An electronic condensate drain shall also be included.
11. Inlet Air Filter
    a. The filter shall be a paper cartridge type and be factory installed inside the compressor enclosure.
    b. The filter shall have the following SAE fine efficiency ratings:
       1) 1 micron: 98.0%

2) 2 microns: 99.5%
3) 3 microns: 99.9%

c. The service interval of the filter must be at least 4,000 hours.

12. Oil System
    a. The oil system shall include an ASME approved air/oil separator with oil level indicator. The service interval of the separator element must be at least 4,000 hours.
    b. The oil filter shall be a spin-on type with an integrated bypass valve. The oil filter element will have a 12 micron beta 75 rating and the service interval must be at least 8,000 hours.
    c. The oil temperature shall be regulated by means of a thermostatic bypass valve. Oil circulation is achieved through differential pressure.
    d. The oil must be synthetic and rated for a change interval of 8,000 hours.
13. Electric Cubicle
    a. The control cubicle must be designed to NEMA 1 or 12 standards.
    b. The unit must have an EMC filter installed.
    c. The unit must have a line reactor (choke) installed.
14. Regulating and Control System
    a. The compressor shall have a regulating system which is of the variable-speed design, controlled by an air compressor discharge pressure sensor which senses the pressure variations at the compressor discharge and adjusts the speed of the compressor to maintain a stable discharge pressure.
    b. The full variable-speed regulation shall be combined with start / stop regulation to automatically stop the compressor as required during low demand periods without idling.
    c. The compressor shall be equipped with an onboard microprocessor controller which will control, monitor and protect the operation and condition of the air compressor.
    d. The controller shall have a 3.5” color display.
    e. The controller shall allow programming of two pressure set points.
    f. Time based start / stop and changeover of the pressure set point shall be programmable.
    g. The controller must be capable of automatically restarting the compressor in the event of a voltage failure.
    h. The controller must be capable of graphing any of the measured temperature or pressure inputs on the display. The time frame of the graph shall be adjustable from 4 minutes to 10 days.
    i. The compressor shall be able to be controlled locally, remotely or via a local area network.
    j. The controller must be equipped with auxiliary contacts for external indication of automatic or manual load control, general warning and general shutdown conditions.
    k. The controller must be capable of providing remote monitoring by a PC through the local Ethernet system via an Ethernet port on the controller.
    l. The controller must be capable of providing remote monitoring via a iPhone, iPad, or Android phone or tablet.
    m. The controller shall monitor the hours of operation and output a message on the display to notify the operator to provide preventative maintenance in accordance with the factory approved service plan.
    n. The control system shall have the capability to monitor the following items:
        1) Discharge air pressure
        2) Element outlet temperature
        3) Ambient temperature
        4) Compressor status
        5) Motor overload status

6) Running hours
7) Loaded hours
8) Regulator hours
9) Compressor protective functions shall include:
10) Emergency stop
11) Element outlet temperature
12) Service warnings
13) Drive and cooling fan motor overload

2.3 GEAR DRIVEN, OIL-LUBRICATED, SINGLE-STAGE, AIR COOLED, ROTARY SCREW AIR COMPRESSOR (AC-2).

A. Gear driven, oil-lubricated, single-stage air cooled rotary screw air compressor:
1. Manufacturers:
a. Atlas Copco Compressors, Inc. Model GA.
b. CompAir; a Brand of Ingersoll-Rand, Inc.
c. Gardner Denver; a Brand of Ingersoll-Rand, Inc.
d. Ingersoll-Rand; a Brand of Ingersoll-Rand, Inc.
e. Kaeser Compressors, Inc.
f. Quincy Compressor.
g. Sullair Corporation.
2. Number of Compressors: One.
3. General
a. The rotary screw air compressor shall be capable of producing and delivering 100% of the required air demand as specified at standard operating conditions.
b. The compressor shall be designed and supplied as a complete package with all necessary equipment, including but not limited to the following components: inlet filter, air compression element, drive motor, aftercooler with integral moisture separator, oil cooler, cooling fan, motor starter, microprocessor regulation and control system. All components shall be mounted on a common solid base frame and fully enclosed with a sound attenuating enclosure.
c. The compressor package shall be rated to operate in ambient conditions from 32°F to 115°F.
4. Compressor Enclosure
a. The compressor shall be enclosed in a steel sound attenuating canopy with removable panels.
b. The sound attenuating material shall be flame retardant polyurethane foam.
5. Noise Levels
a. The compressor package shall not exceed 69 dB(A) when measured in the free field conditions at one meter in accordance with the CAGI-Pneurop Test Code.
6. Compressor Element
a. The compression profile shall be of the asymmetric profile design with four lobes on the male rotor and six lobes on the female rotor.
b. The male and female rotors shall have the same diameter.
c. The element housing shall be of cast iron construction.
7. Drive Motor
a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section "Motors."
1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
8. Drive Arrangement
a. The drive arrangement shall be a gear-driven design.
b. The drive system shall be fully enclosed to protect against dirt and dust intrusion.

c. The drive gear shall be directly mounted on the end of the motor shaft eliminating the need for a coupling.
d. The driven gear shall be helically cut to exert compensating thrust on the rotors to offset axial loads generated during compression.

9. Cooling System
   a. The compressor package shall be fitted with an aluminum, air-cooled, oil cooler and aftercooler.
   b. The cooling system shall include a radial cooling fan.
10. Moisture Separator
   a. The compressor shall be equipped with a labyrinth style moisture separator integrated in the discharge side of the after-cooler.
11. Electronic Water Drain
   a. The compressor will have a zero loss electronic water drain plumbed to the aftercooler.
   b. These drains shall discharge no compressed air during removal of the condensate.
   c. The zero loss drains shall be monitored by the microprocessor controller.
   d. A manual condensate drain shall also be included.
12. Inlet Air Filter
   a. The filter shall be a paper cartridge type and be factory installed inside the compressor enclosure.
   b. The filter shall have the following SAE fine efficiency ratings:
      1) 1 micron: 98.0%
      2) 2 microns: 99.5%
      3) 3 microns: 99.9%
   c. The service interval of the filter must be at least 4,000 hours.
13. Oil System
   a. The oil system shall include an ASME approved air/oil separator with oil level indicator. The service interval of the separator element must be at least 8,000 hours.
   b. The oil filter shall be a spin-on type with an integrated bypass valve. The oil filter element will have a service interval that must be at least 8,000 hours.
   c. The oil temperature shall be regulated by means of a thermostatic bypass valve. Oil circulation is achieved through differential pressure.
   d. The oil must be synthetic and rated for a change interval of 8,000 hours.
14. Electric Cubicle
   a. The control cubicle must be designed to NEMA 1 or 12 standards.
   b. The cubicle must include a cooling fan and vent to force ambient air through the cubicle.
   c. A wye-delta starter must be used to start the main drive motor.
15. Regulating and Control System
   a. The compressor shall have a regulating system which is of the full load / no load design, controlled by an air compressor discharge pressure sensor which senses the pressure variations at the compressor discharge and maintains it within a pre-set adjustable range.
   b. The full load / no load regulation shall be combined with a start / stop regulation to automatically stop the compressor as required.
   c. The compressor shall be equipped with an onboard microprocessor controller which will control, monitor and protect the operation and condition of the air compressor.
   d. The controller shall have a 3.5” color display.
   e. The controller shall allow programming of two pressure bands for loading and unloading.
   f. Time based start / stop and changeover for net pressure band shall be programmable.

g. The control algorithm shall include a function to proactively stop the compressor during periods of low demand without having to wait for the stop timer to time out.
h. The controller must be capable of automatically restarting the compressor in the event of a voltage failure.
i. The controller must be capable of graphing any of the measured temperature or pressure inputs on the display. The time frame of the graph shall be adjustable from 4 minutes to 10 days.
j. The compressor shall be able to be controlled locally, remotely or via a local area network.
k. The controller must be equipped with auxiliary contacts for external indication of automatic or manual load control, general warning and general shutdown conditions.
l. The controller must be capable of providing remote monitoring by a PC through the local Ethernet system via an Ethernet port on the controller.
m. The controller must be capable of providing remote monitoring via a iPhone, iPad, or Android phone or tablet.
n. The controller shall monitor the hours of operation and output a message on the display to notify the operator to provide preventative maintenance in accordance with the factory approved service plan.
o. The control system shall have the capability to monitor the following functions:
    1) Discharge air pressure
    2) Element outlet temperature
    3) Ambient temperature
    4) Compressor status
    5) Motor overload status
    6) Running hours
    7) Loaded hours
    8) Regulator hours
    9) Compressor protective functions shall include:
        a) Emergency stop
        b) Element outlet temperature
        c) Drive and cooling fan motor overload
        d) Service warnings

2.4 AIR-INLET FILTERS

A. Manufacturers:
    1. SPX Flow Technology; Dollinger.
    2. Donaldson Filtration Solutions.
    3. Universal Silencer Corp.
    4. Solberg Manufacturing, Inc.; (SMI).
B. Description: Combination inlet filter-silencer, suitable for remote installation, for each air compressor.
    1. Construction: Weatherproof housing for cleanable, dry-type filter element, with silencer tubes or other method of sound reduction.
    2. Capacity: Match capacity of air compressor, with collection efficiency of 99 percent retention of particles larger than 20 microns.

2.5 REGENERATIVE DESICCANT COMPRESSED AIR DRYER

A. Manufacturers:
    1. Donaldson Filtration Solutions.
    2. SPX Flow Technology; Deltech.
    3. SPX Flow Technology; Hankison International
    4. Van Air Systems, Inc.
    5. Wilkerson Corp.

6. ZEKS Compressed Air Solutions.

B. The design, fabrication, and delivery of an air dryer system (coalescing prefilter, dryers, afterfilters, piping, and instrumentation) complete and in conformance with this specification.

C. Regenerative desiccant compressed air dryer shall be packaged, heatless, dual tower, skid mounted type. Unit shall be capable of reducing the moisture content of the scheduled air compressors SCFM at the compressors discharge pressure and temperature to maintain a pressure dewpoint of dried air at minus 40 deg F.

D. Equipment Design Details
   1. Dryer shall provide air with effluent dew point and quality in accordance with the attached Purification System Summary Sheet.
   2. Dryer shall be of dual chamber design with each chamber filled or capable of being filled with equal quantities of adsorbing desiccant.
   3. The drying flow shall be downward to minimize fluidization of the desiccant in the event of upset conditions.
   4. Regeneration flow shall be counter-current to the direction of the inlet gas flow.
   5. Each desiccant chamber shall be fitted with fill and drain ports to facilitate filling and draining of desiccant.
   6. Each chamber shall be provided with a stainless steel slotted inlet diffuser screen and a desiccant bed support screen.
   7. Chambers shall be fitted with a pressure relief valve.
   8. Chambers are not to be supported by interconnecting piping in any way.
   9. Desiccant vessels shall be designed in accordance with the ASME Pressure Vessel Code and shall be stamped by the code inspector.
   10. All dryers requiring more than one voltage shall be supplied with a control voltage transformer. If the higher voltage exceeds 230 volts, separate high and low tension enclosures shall be provided.
   11. Fail-Safe Mode: Any power interruption to the dryer shall not result in interruption of the airflow through the dryer.
   12. Only dry, oil free outlet air shall be used for pilot air necessary for dryer operation. A high surface area pilot air line filter with a .9 micron absolute rating shall be furnished for this service.
   13. All vessels, steel piping and structural supports shall be shot blasted to remove scale and rust prior to painting. No visible oxidation of the surface shall be permitted between the time of blasting and priming.
   14. Surfaces prepared per item 4.13 above shall be coated with an epoxy based zinc chromate/iron oxide primer and a two-part high solids epoxy top coat.

E. Non-Heat Regenerated Type
   1. The velocity of the gas being dried shall be less than that which would fluidize the bed.
   2. Dryer pressure drop shall not exceed 5.0 psig at rated flow, temperature and pressure.
   3. Depressurization shall be co-current to regeneration and shall be controlled to prevent fluidization of the desiccant.
   4. Regeneration shall be accomplished without the use of heaters (internal or external).
   5. Dryer shall be supplied with purge flow indicator and adjustable valve with calibration curves to compensate for changes in operating conditions.
   6. Dryer shall be furnished with a means of repressurization to allow the regeneration chamber to reach line pressure prior to changeover.
   7. Dryer shall be furnished with an exhaust muffler and flow restrictor to limit noise during dump and purge cycles.
   8. Valves shall be non-lubricated poppet type, and of suitable design for high cycle service of non-heat regenerated dryers. Valve internals shall be stainless steel,

and positively pilot actuated. Bodies must be high strength carbon steel, coated internally with PTFE.

9. Switching valves shall be designed with low breakaway requirements. The vendor shall state in his proposal the pilot air pressure required. Ball valves and plug valves are not acceptable.
10. Manufacturer shall have bubble-point-tested valve for a minimum of 1,000,000 cycles without failure. Test reports shall be submitted upon request.
11. Valve operators are to be supplied with permanently lubricated packing.
12. The calculated desiccant life shall be stated and guaranteed by the Vendor.

F. An Energy Saving Demand Cycle Control:
1. Assure full utilization of the moisture holding capacity of the desiccant bed before regenerating the bed. Purge consumption shall be minimized by reducing the number of regeneration cycles during periods of lower than design flow.
2. Maintain outlet dew point at or below the specified level throughout the drying period.
3. Moisture sensing must be accomplished via a capacitance measurement of actual moisture on the desiccant, other methods of sensing are not acceptable. Method shall be described in detail.
4. Must utilize industrially hardened, abrasion and liquid water-resistant moisture sensing probes. Capacitance-type sensing probes are preferred. Recalibration must be kept to a minimum. Recalibration requirements must be stated within quote.
5. Sensing probes must be warranted for the life of the dryer.
6. The dryer controller shall be comprised of intrinsically reliable and durable components not susceptible to shorting and corrosion.
7. The controller shall be responsible for initiation and monitoring of the dryer operation. The control shall contain built-in diagnostics to check each operation as it is initiated, secure it, and ensure its continuation. The controller must have RS-232 communication capability for remote monitoring.

G. The Controller Shall Have The Following Features:
1. All electrical components housed within a NEMA 4 or NEMA 4X control enclosure.
2. Automatic switching of control valving by solenoid valves that have been cycle tested for 5,000,000 cycles. The solenoid valves must have valve position indicators and manual overrides.
3. Automatic fail-safe operation of inlet and exhaust valves insuring no interruption of customer flow during power dips/outages.
4. Diagnostics including POWER-ON; LEFT/RIGHT CHAMBER DRYING; VALVE MALFUNCTION (Switching Failure).
5. The energy saving demand cycle control shall include the preceding diagnostics along with High Humidity, energy savings and a fixed cycle mode.
6. Watch-Dog timer to prevent lock-up or scramble during power dips/outages.
7. Common alarm relay with contacts for connection of customer supplied remote alarm.
8. The energy saving demand cycle controller must automatically control and limit purge cycles to only that required to insure desiccant bed regeneration.
9. The energy saving demand cycle controller must be equipped for automatic switchover to "FIXED-CYCLE" operation during periods of high moisture loading (i.e., overload conditions).
10. The energy saving demand cycle controller will include a synoptic display board showing flow pattern in progress.
11. The energy management demand cycle control shall include a message center - 80-character liquid crystal display.
12. The energy management demand cycle control shall include a chamber performance degrading alarm. An alarm light and message shall be provided to show that chamber performance is degrading (a high humidity condition is

approaching). If a malfunction of the moisture sensing system occurs, the dryer shall be automatically switched to a fail-safe fixed cycle operating mode. The liquid crystal display shall show the mode of operation (Fixed Cycle or Demand cycle).

H. Standard Instrumentation Shall Include:
   1. Locally mounted purge flow indicator
   2. Panel mounted weatherproof chamber and inlet/outlet pressure gauges.
   3. Panel mounted visual-type color change outlet moisture indicator.
   4. Switching Failure alarm for Inlet and Purge Exhaust Valves. The energy management demand cycle control shall include a liquid crystal display indicating which chamber the failure has occurred.
   5. Dry contacts for customers alarm circuit shall be provided.

I. Prefilter
   1. The prefilter shall be a high efficiency, inside to outside flow element-type coalescing filter. It shall be designed to provide high efficiency removal of liquids and solids after becoming fully saturated with liquids. The prefilter shall be made up of a coalescing filter element to remove the liquids, a housing (bowl) to contain the element and the captured liquids with both parts combined to form a complete assembly. Said assembly shall be fitted with a bypass valve and piping around the filter and drain port to provide a pathway to eliminate the collected liquid(s) The filter element must be positively sealed to the filter housing using elastomeric seals. The media shall be well supported inside and out.
   2. Performance:
      a. The prefilter assembly shall have a clean, dry pressure drop of less than 1.5 PSID.
      b. When challenged with influent oil, content ranging from one to 50 PPMW, the prefilter should consistently provide effluent oil levels less than 0.001 PPMW.
      c. The prefilter shall remove all particulates greater than 0.6 microns.
      d. The filter media must be pleated to maximize available surface area and minimize pressure drop. The media must be a fixed uniform bonded pore structure to prevent unloading, channeling and media migration.
   3. Housing Construction:
      a. The prefilter housing will allow for service of the elements without removing the entire assembly from the system.
      b. The prefilter bowl will provide sufficient sump volume to prevent liquid re-entrainment
   4. Drain Valve:
      a. The drain valve must be completely automatic with an electronic timer. The valve must discharge accumulated fluids with minimum air loss.
      b. The timer shall have dual adjustments to precisely match contaminant load.

J. Afterfilter
   1. The afterfilter shall be a particulate filter designed to prevent solid particulates from entering the compressed air stream. The afterfilter shall be placed in the compressed air stream after the air dryer to capture desiccant particulates before they pass downstream. The afterfilter shall be made up of a particle removal element to capture solid particles and a housing to contain the element. Filter element must positively seal to the filter housing using elastomeric seals. Media shall be well supported inside and out. Provide a bypass valve around the afterfilter.
   2. Performance:
      a. The afterfilter element shall have an absolute filtration rating of 0.9 microns.
      b. The clean afterfilter assembly pressure drop shall be no greater than 1.0 psid. Each afterfilter element shall be able to withstand a maximum differential pressure of 100 psid in the normal flow direction.
      c. The afterfilter assembly for non-heat reactivated dryers shall have a standard temperature rating of 200°F.

3. Housing Construction:
    a. The housing will provide the connection to the compressed air system and allow for the attachment of both the filter element and the bowl. The housing will allow for service of the element without removing the entire assembly from the system.

2.6 ACCESSORIES

A. General: Include accessories with working-pressure rating not less than system pressure at location where used, and compatible with equipment and piping system used.
B. Oil/Water Separator:
    1. Acceptable Manufacturers that meet spec:
        a. Oil/water Separator: Clean Resources, Batavia, IL
        b. Oil/water Separator: Gardner Denver, Quincy, IL
    2. Manufacturer equals must be submitted to the engineer for approval at least __ days prior to bidding. If approved, the engineer will then forward addendum out for contractor's consideration.
    3. Capability
        a. 15-25 Gallon Unit designed for Compressor HP Range of 50-75 and 2 GPM
    4. Oil/water separator shall be for any combination of free floating oil in water.
    5. Operating temperatures of the influent oil/water mixture shall range from 400 F to 1500.
    6. Inlet and Outlet Piping: As indicated on drawings and one 3/4" outlet T's for the described separator system.
    7. Inlet hose/piping to the OWS tank may be connected directly to unit under plant pressure. Any inline drains that operate under gravitational pressure only must be run in a downward slope to the OWS.
    8. Outlet piping MUST run in a downward slope to drain as discharge flows under gravitational pressure only.
    9. Vent Cap: Provided a vent to diffuse main line pressure.
    10. NOTE: If condensate/oil mix reaches the vent cap there is a plug in the unit most often found in the discharge hose. Blockage removal will allow unit to return to normal condensate levels.
    11. The OWS tank inlet, outlet, and the tank itself must be vented separately to the atmosphere to ensure proper operation of the OWS tank. See drawing for details.
C. Receiver: ASME construction steel tank.
        a. Orientation: Vertical arrangement.
        b. Capacity and Pressure Rating: Refer to schedule on Drawings.

2.7 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet safety valve for compressed-air service.
    1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
B. Automatic Drain Valves: Electrical operation type with corrosion-resistant metal body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.
C. Pressure Regulators: Bronze body, direct acting, spring loaded, manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.
    1. Type: Diaphragm or pilot operated.
    2. Manufacturers:
        a. Emerson Process Management; Fisher Controls.
        b. IMI Norgren.

c. Watts Fluid Air; Division of Parker-Hannifin.

D. Pressure Regulators: Aluminum alloy or plastic body, diaphragm operated, direct acting, spring loaded, manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.
   1. Manufacturers:
      a. Emerson Process Management; Fisher Controls.
      b. IMI Norgren.
      c. Watts Fluid Air; Division of Parker-Hannifin.

E. Compressed-Air Filters:
   1. Manufacturers:
      a. Donaldson Filtration Solutions.
      b. SPX Flow Technology; Dollinger.
      c. SPX Flow Technology; Deltech.
      d. Ultrafilter Inc.
      e. Zeks Air Drier Corporation.
   2. Mechanical-Separation Filters: Two-stage air-line filters of capacity not less than that of connected equipment. Equip with deflector plates; resin-impregnated-ribbon-type filters with edge filtration, 40 micrometers thick; and drain chock.
   3. Coalescing Filters: Capacity not less than that of connected equipment; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Equip with activated carbon capable of removing water and oil aerosols.

2.8 COMPUTER INTERFACE CABINET

A. Description:
   1. Wall mounting.
   2. Welded steel with white enamel finish.
   3. Gasketed door.
   4. Grounding device.
   5. Factory-installed, signal circuit boards.
   6. Power transformer.
   7. Circuit breaker.
   8. Wiring terminal board.
   9. Internal wiring capable of interfacing 20 alarm signals.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases for compressed-air equipment. Concrete base is specified in Division 20 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 03.

3.2 EQUIPMENT INSTALLATION

A. Vibration Isolation: Mount equipment with motors larger than 5 hp on vibration isolation equipment base as specified in Division 20 Section "Mechanical Vibration Controls."

B. Maintain manufacturer's recommended clearances for service and maintenance.

C. Install the following devices on compressed-air equipment:
   1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
   2. Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.
   3. Automatic Drain Valves: Install on intercoolers, aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.
C. Connect piping to air compressors and receivers, except safety relief valve connections, with flexible pipe connectors of materials suitable for service. Flexible pipe connectors and their installation are specified in Division 22 Section "General-Service Compressed-Air Piping."
D. Ground equipment according to Division 26 Section "Grounding and Bonding."
E. Connect wiring according to Division 26 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.

3.4 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for compressed-air equipment. Refer to Division 20 Section "Mechanical Identification" for labeling and identification materials.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to test, inspect, and adjust components and equipment installation and to perform startup service.
B. Perform the following final checks:
    1. Verify that specified tests of piping systems are complete.
    2. Verify that potable-water supply connections to equipment have correct backflow preventer.
    3. Check for piping connection leaks.
    4. Check for lubricating oil in lubricated-type equipment.
    5. Check belt drives for proper tension.
    6. Verify that air-compressor inlet filters and piping are clear.
    7. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
    8. Check safety valves for correct settings. Ensure that settings are greater than air-compressor discharge pressure but not greater than rating of system components.
    9. Test operation of equipment safety controls and devices.
    10. Drain receiver tanks.
C. Verify that compressed-air equipment is installed and connected according to the Contract Documents.
D. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements in Division 26 Sections.
E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
G. Complete installation and startup checks according to manufacturer's written instructions.
H. Prepare written report documenting testing procedures and results.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain general-service compressed-air equipment.

END OF SECTION 22 1519

SECTION 22 3500
DOMESTIC WATER HEAT EXCHANGERS

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 Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUBMITTALS

A. Product Data: For each type and size of heat exchanger indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Product Certificates: For each type of heat exchanger, signed by product manufacturer.
D. Source quality-control test reports.
E. Field quality-control test reports.
F. Operation and Maintenance Data: For heat exchangers to include in operation and maintenance manuals.
G. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of heat exchangers through one source from a single manufacturer.
B. Product Options: Drawings indicate size, profiles, and dimensional requirements of heat exchangers 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 an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

D. The water heaters shall be ETL listed as a complete unit. The heater shall satisfy current Federal Energy Policy Act standards for stand-by heat losses as established for indirect fired water heaters incorporating storage tanks.
E. ASME Compliance: Where ASME-HLW stamped and National Board Registered for a maximum allowable working pressure of 150 psi and pressure tested at 1-1/2 times working pressure.
F. Water heater will meet the tank insulation requirements of ASHRAE 90.1-2010.
G. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with water.

1.4 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of pumps that fail in materials or workmanship within 60 months from date of project acceptance. Contractor shall troubleshoot issues within 24 hours of notification by the Owner. Warranty shall include all parts, labor, travel time and expenses.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including heat exchanger, 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. Noncirculating, Storage Heat Exchangers:
         1) Storage Tank: 15 Fifteen years full coverage.
         2) Heat Exchanger: Five years.
         3) Controls and Other Components: Five years.
B. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

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 SEMI-INSTANTANEOUS HEAT EXCHANGERS

A. Heating-Fluid-in-U-Tube-Coil, Semi-Instantaneous Heat Exchangers:
   1. Manufacturers:
      a. Ajax Boiler Inc.; Ace Boiler Div.
      b. Cemline Corporation SEH Series.
      c. Patterson-Kelley.
      d. PVI Industries, LLC.
      e. RECO USA.

2. Description: Tankless, packaged assembly of heat-exchanger coil, controls, and specialties for heating domestic water in shell with steam in coil.
3. Construction: ASME-code, negligible-capacity, copper-lined carbon-steel, nickel-plated carbon steel, low nickel, lean duplex stainless steel alloy UNS S32101, or copper-alloy shell with 150-psig minimum working-pressure rating.
    a. Configuration: Vertical.
    b. Shell Tappings: Factory fabricated of materials compatible with water heater 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.
    c. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle except connections and controls.
    d. Heat-Exchanger Coil: Copper, double-wall, U tubes for heating fluid.
        1) Tube Pressure Rating: Equal to or greater than heating-fluid supply pressure.
4. Temperature Control: Adjustable thermostat that operates steam-control valve and capable of maintaining outlet-water temperature within 5 deg F of setting.
5. Safety Control: Automatic, high-temperature-limit cutoff device or system.
6. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, 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 working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into shell.
7. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping.
8. Stand: Factory fabricated for floor mounting.
9. Capacity and Characteristics: Refer to Schedules on Drawings.

2.3 NONCIRCULATING, STORAGE HEAT EXCHANGERS

A. Storage Heat Exchangers:
    1. Manufacturers:
        a. PVI; a Watts Brand; QuickDraw Series.
        b. Adamson Global Technology Corp.
        c. Cemline Corporation.
        d. Patterson-Kelley.
        e. RECO USA.
        f. Smith, A. O. Water Products Company.
B. Construction
    1. Water heater will be a completely factory packaged on a single skid, storage-type design indirectly heated by steam through a copper u-tube bundle.
    2. The storage section of the water heater shall be ASME HLW stamped and National Board Registered for a maximum allowable working pressure of 150 psi and pressure tested at 1-1/2 times working pressure.
    3. All tank connections/ fittings shall be nonferrous. Tank shall be equipped with a ball-type drain valve. Tank design will include a manway sized access to the tank interior.
    4. The storage tank shall be vertical, unlined pressure vessel constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as

defined in ISO 3651-2and ASTM G123 - 00(2005) “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”

5. Waterside surfaces shall be welded internally utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.
6. All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.
7. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.
8. Water contacting tank surfaces will be non-porous and exhibit 0% water absorption.
9. Lined or plated storage tanks will not be acceptable.
10. The water heater will not require anode rods and none will be used. Tanks that employ anodes will not be acceptable.
11. The heat exchanger shall be a double-wall copper u-tube bundle ASME stamped to section VIII. Heat exchanger’s tube sheet, tie rods and baffles will be non-ferrous.
12. Steam will be controlled through one or more pilot operated solenoid steam valves.

C. Water Heater Trim
   1. As a minimum, the heater will be equipped with the following:
      a. an immersion operating thermostat
      b. an immersion temperature limiting device
      c. an ASME- or AGA-rated temperature and pressure relief valve
      d. and options as selected on form PV 8146
   2. Operating and safety controls shall meet the requirements of ETL The water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a building automation system through serial connection using Modbus RTU protocol.
   3. A protocol gateway for BacNet MSTP/IP will be provided.

2.4 EXPANSION TANKS

A. Description: Steel, pressure-rated tank, ASME-code 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. Bell & Gossett; Xylem Inc.
      d. Taco, Inc.
      e. Wessels Co.
   2. Construction:
      a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

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: Refer to Schedules on Drawings.

2.5 HEAT-EXCHANGER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select relief valves with sensing element that extends into heat-exchanger storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than working-pressure rating of heat exchanger.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect heat-exchanger storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test heat-exchanger storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install domestic water heat exchangers on concrete bases.
1. Concrete base construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Install domestic water heat exchangers 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 domestic water heat exchangers to substrate.

D. Install temperature and pressure relief valves in top portion of storage tank shells of heat exchangers with domestic water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install domestic water heat-exchanger 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 heat exchangers that do not have tank drains. Refer to Division 20 Section "Valves" for hose-end drain valves.

F. Install thermometer on each heat-exchanger domestic-water outlet piping, and install thermometer on each heat-exchanger heating-fluid outlet piping. Refer to Division 20 Section "Meters and Gages" for thermometers.

G. Fill heat exchangers with water.

H. Charge expansion tanks with air.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to heat exchangers to allow service and maintenance. Arrange piping for easy removal of heat exchangers.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."
D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. 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 heat exchangers 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 heat exchangers.

END OF SECTION 22 3500

SECTION 22 4200
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.

B. Related Sections include the following:
   1. Division 10 Section "Toilet and Bath Accessories."
   2. Division 20 Section “Mechanical General Requirements.”
   3. Division 20 Section “Basic Mechanical Materials and Methods.”
   4. Division 22 Section "Drinking Fountains and Water Coolers."
   5. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers; individual-fixture, water tempering valves; and specialty fixtures not included in this Section.
   6. Division 22 Section “Drainage Piping Specialties” for floor drains, and specialty fixtures not included in this Section.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
E. 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.
F. FRP: Fiberglass-reinforced plastic.
G. PMMA: Polymethyl methacrylate (acrylic) plastic.
H. PVC: Polyvinyl chloride plastic.
I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 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. Operation and Maintenance Data: For plumbing fixtures and trim to include in operation and maintenance manuals.

1.4 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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" for plumbing fixtures for people with disabilities.
C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
F. Comply with applicable ANSI, ASME, ASSE, ASTM, ICC, NSF, and UL standards and other requirements specified for plumbing fixtures, trim, fittings, components, and features.

PART 2 - PRODUCTS

2.1 HIGH EFFICIENCY WATER CLOSETS

A. Water Closets, WC-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.; Afwall FloWise Elongated Toilet 1/28GPF.
      b. Kohler Co.; K 4325Kingston.
   2. Description: Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Style: Flushometer valve.
         1) Bowl Type: Elongated with siphon-jet design.
         2) Supply Spud Location: Top.
         3) Design Consumption: 1.28 gal./flush.
         4) Color: White.

b. Flushometer: HET-FV-1.
c. Toilet Seat: TS-1.
d. Fixture Support: Water-closet support combination carrier.

B. Water Closets, WC-2:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard Companies, Inc.; Madera 16-1/2 Elongated Toilet.
b. Kohler Co.
c. Sloan Valve Company.
d. Zurn Plumbing Products Group.
2. Description: Accessible, floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.
a. Style: Flushometer valve.
1) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
2) Supply Spud Location: Top.
3) Height: 16-1/2 to 16-3/4 inches, universal/accessible.
4) Design Consumption: 1.28 gal./flush.
5) Color: White.
b. Flushometer: HET-FV-1.
c. Toilet Seat: TS-1.

2.2 HIGH EFFICIENCY WATER CLOSET FLUSHOMETERS

A. Flushometers, HET-FV-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Sloan Valve Company Royal Model 111-1.28.
2. Description: High efficiency flushometer for water-closet-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
a. Internal Design: Diaphragm operation.
b. Style: Exposed.
c. Inlet Size: NPS 1.
d. Trip Mechanism: Oscillating, low-force ADA compliant lever-handle actuator.
e. Consumption: 1.28 gal./flush.
f. Tailpiece Size: NPS 1-1/2 and standard length to top of bowl.

2.3 HIGH EFFICIENCY URINALS

A. High Efficiency Urinals, UR-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard Companies, Inc.; Washbrook FloWise 0.125.
b. Kohler Co.; Bardon K 4904.
2. Description: Wall-mounting, back-outlet, ultra-low water consumption, vitreous-china fixture designed for flushometer valve operation.
a. Type: High efficiency.
b. Strainer or Trapway: Open trapway with integral trap.
c. Design Consumption: 1/8 gal./flush.
d. Color: White.
e. Supply Spud Size: NPS 3/4.
f. Supply Spud Location: Top.
g. Outlet Size: NPS 2.
h. Flushometer: HEU-FV-1
i. Fixture Support: Wall mounting bracket.

2.4 HIGH EFFICIENCY URINAL FLUSHOMETERS

A. Flushometers, HEU-FV-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Sloan Valve Company.
   2. Description: High efficiency flushometer for high efficiency urinal fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, courtesy flush feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
      a. Internal Design: Diaphragm or piston operation.
      b. Style: Exposed.
      c. Inlet Size: NPS 3/4.
      d. Trip Mechanism: Oscillating, low force ADA compliant lever-handle actuator.
      e. Consumption: 1/8 gal./flush.
      f. Tailpiece Size: NPS 3/4 and standard length to top of fixture.

2.5 TOILET SEATS

A. Toilet Seats, TS-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bemis Manufacturing Company; 1955SSC/1955SSCT.
      b. Centoco Manufacturing Corp.
      c. Church Seats; 295SSC/295SSCT.
      d. Ferguson Enterprises, Inc.; ProFlo PFTSCOF2000WH.
      e. Olsonite Seat Company; Model 10SSC/10SSCT.
      f. Sanderson Plumbing Products, Inc.; Beneke Div.
      g. Zurn Plumbing Products Group; 5955STS-WH.
   2. Description: Toilet seat for water-closet-type fixture.
      a. Material: Molded, solid plastic.
      b. Configuration: Open front without cover.
      c. Size: Elongated.
      d. Hinge Type: SC, self-sustaining, check.
      e. Class: Standard commercial.
      f. Color: White.

2.6 LAVATORIES

A. Lavatories, LAV-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.; Ovalyn 9482.
      b. Kohler Co.; K 2211 Caxton.
   2. Description: Accessible, under-counter mounting, vitreous-china fixture with unglazed rim, and concealed overflow.
      a. Oval Lavatory Size: 19 by 16 inches.
      b. Color: White.
      c. Faucet: LF-1.
      d. Water Temperature Limiting Device: Required.
      e. Drain: Grid.
      f. Drain Piping: NPS 1-1/4 chrome-plated, cast-brass P-trap; NPS 1-1/4, 17 gage tubular brass waste to wall; and wall escutcheon.

B. Lavatories, LAV-2:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.; Lucerne Model 0355.012.
      b. Kohler Co.; K 2005 Kingston.

2. Description: Accessible, wall-mounting, vitreous-china fixture.
    a. Type: With contoured back and side shields.
    b. Size: 20 by 18 inches rectangular.
    c. Faucet Hole Punching: Single hole.
    d. Color: White.
    e. Faucet: LF-1.
    f. Water Temperature Limiting Device: Required.
    g. Drain: Grid.
    h. Drain Piping: NPS 1-1/4 chrome-plated, cast-brass P-trap; NPS 1-1/4, 17 gage tubular brass waste to wall; and wall escutcheon.
    i. Fixture Support: Lavatory with concealed arms.

2.7 LAVATORY FAUCETS

A. Lavatory Faucets, LF-1:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Chicago Faucets.
        b. Delta Faucet Company; Model 22C601.
    2. Description: Single handle mixing faucet, vandal resistant, single hole, with metal grid strainer, no lift rod hole, high temperature limit stop.
        a. Body Material: Commercial, all metal construction meeting NSF 61.
        b. Finish: Polished chrome plate.
        c. Mounting: Deck, concealed.
        d. Inlet(s): NPS 1/2.
        e. Spout Outlet: Vandal resistant aerator.
        f. Maximum Flow Rate:
            1) 1.5 gpm.

2.8 COUNTER-MOUNTING SINKS

A. Sinks, SK-1:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Elkay Manufacturing Co.
        b. Franke Consumer Products, Inc., Commercial Div.
        c. Just Manufacturing Company.
        d. Moen Commercial.
    2. Description: Accessible single-bowl, counter-mounting, lay-in stainless-steel sink.
        a. Overall Dimensions: 22 inches left to right by 19 inches front to back.
        b. Metal Thickness: 18 gage, with sound dampened underside.
        c. Bowl:
            1) Dimensions: 18 inches by 14 inches by 6 inches deep.
            2) Drain: 3-1/2-inch grid with offset waste.
        d. Sink Faucet: SF-1.
        e. Water Temperature Limiting Device: As required by code.
        f. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; 17 gage tubular brass waste to wall; and wall escutcheon(s).
        g. Disposer: Not required.
        h. Dishwasher Air-Gap Fitting: Not required.
        i. Hot-Water Dispenser: Not required.
B. Sinks, SK-2:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Elkay Manufacturing Co.
        b. Franke Consumer Products, Inc., Commercial Div.
        c. Just Manufacturing Company.

d. Moen Commercial.
2. Description: Wall-mounting, Type 304 stainless-steel, commercial fixture, radius coved corner.
a. Overall Dimensions: 16-3/4inches left to right by 15-1/2 inches front to back.
b. Metal Thickness: 18 gage, with sound dampened underside.
c. Bowl:
1) Dimensions: 12 inches by 9-1/4 inches by 6 inches deep.
2) Drain: Chrome plated stamped brass perforated strainer grid.
d. Sink Faucet: SF-2.
e. Water Temperature Limiting Device: As required by code.
f. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; 17 gage tubular brass waste to wall; and wall escutcheon(s).
g. Backsplash: 7-inch high.

2.9 SERVICE SINKS

A. Service Sink, MS-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard Companies, Inc.; Florwell Cast Iron Service Sink.
b. Kohler Co.; Whitby K 6710.
c. Zurn; Z5850 Series.
2. Description: Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard.
a. Size: 28 by 28 inches.
b. Color: White.
c. Faucet: Sink SF-3.
d. Drain: Grid with NPS 3 outlet.

B. Service Sink, SS-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard Companies, Inc.; Lakewell Service Sink.
b. Kohler Co.; Bannon K-6718
c. Zurn Plumbing Products; Z5888.
2. Description: Trap-standard- and wall-mounting, enameled, cast-iron fixture with roll-rim with plain back and rim guard on front and sides
a. Size: 22 by 18 inches.
b. Faucet: Sink SF-4.
c. Drain: Grid with NPS 3 outlet.
d. Trap Standard: NPS 3 (DN 80) enameled, cast iron with cleanout and floor flange.
e. Fixture Support: Sink.

2.10 SPECIAL LAB/CLASSROOM SINKS AND FAUCETS:

A. Refer to Plumbing Fixture Schedule on Drawings.

2.11 SINK FAUCETS

A. Sink Faucets, SF-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Chicago Faucets; No. 1100-GN2AE35-317AB.
b. Delta Faucet Company.
2. Description: Sink faucet. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
a. Body Material: Commercial, solid brass.

b. Finish: Polished chrome plate.
c. Mixing Valve: Two handle.
d. Centers: 8 inches.
e. Mounting: Deck.
f. Handle(s): Wrist blade, 4 inches.
g. Operation: Noncompression, manual.
h. Inlet(s): NPS 1/2.
i. Spout Type: 70-degree restricted swing gooseneck.
j. Spout Outlet: Aerator.
k. Maximum Flow Rate:
1) 1.5 gpm.

B. Sink Faucets, SF-2:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Chicago Faucets; No. W8W-GN2AE1-369ABCP.
b. Delta Faucet Company.
2. Description: Wall mounted fixed centers hot and cold water workboard sink faucet; include hot and cold water indicators, coordinate faucet inlets with supplies and fixture holes.
a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
d. Mixing Valve: Two handle.
e. Centers: 8 inches.
f. Mounting: Back/wall.
g. Handle(s):2-3/8 inch levers.
h. Inlet(s): NPS 1/2.
i. Spout Type: Rigid.

C. Sink Faucets, SF-3:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Chicago Faucets; No. 897-CP.
b. Delta Faucet Company.
2. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. Include 5 foot rubber hose and wall mounted hose clamp.
a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
d. Mixing Valve: Two handle.
e. Centers: 8 inches.
f. Mounting: Back/wall.
g. Handle(s): Lever.
h. Inlet(s): NPS 1/2.
i. Spout Type: Rigid, solid brass with pail hook.
j. Vacuum Breaker: Required.
k. Operation: Noncompression, manual.

D. Sink Faucets, SF-4:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Chicago Faucets; No. 305 VBCP.
b. Delta Faucet Company.
2. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate

faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. Include 5 foot rubber hose and wall mounted hose clamp.
a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
d. Mixing Valve: Two handle.
e. Centers: 8 inches.
f. Mounting: Back/wall.
g. Handle(s): Lever.
h. Inlet(s): NPS 1/2.
i. Spout Type: Rigid, solid brass with pail hook.
j. Vacuum Breaker: Required.
k. Operation: Noncompression, manual.

2.12 FIXTURE SUPPLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. BrassCraft; a Masco Company.
2. McGuire Mfg. Co., Inc.
3. Any of the approved plumbing fixture manufacturers.

B. Description: Chrome-plated brass, loose-key or screwdriver angle stops with brass stems; rigid, chrome-plated copper risers; and chrome-plated wall flanges.

2.13 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers (PSG-1):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Engineered Brass Co.
b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
c. McGuire Manufacturing Co., Inc.
d. Plumberex Specialty Products Inc.
e. TCI Products; SG-200BV.
f. TRUEBRO, Inc.
g. Zurn Plumbing Products Group; Z8946-3-NT.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.14 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
3. Tyler Pipe; Wade Div.
4. Smith, Jay R. Mfg. Co.
5. MIFAB Manufacturing Inc.

B. Water-Closet Supports:
1. Description: Compact type, combination carrier designed for wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space. Supports shall be capable of supporting 500 lbs.

C. Urinal Supports:

1. Description: For wall-mounting, urinal-type fixture. Plate type wall mounting bracket.

D. Lavatory Supports:
   1. Description: Lavatory carrier with concealed arms and tie rods for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
   2. Accessible-Fixture Support: Include rectangular steel uprights.

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. Install accessible fixtures at heights required by local codes.
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: Fixtures with flushometer valves, and faucets or valves with integral stops.
H. Install ASSE 1070 water-temperature limiting devices on supplies for lavatories and sinks that will be used for handwashing, and where specified. Refer to Division 20 Section “Domestic Water Piping Specialties.”
I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
K. Install protective shielding guards PSG-1 on exposed traps and supplies of lavatories, and sinks used for hand washing.
L. Install toilet seats on water closets.
M. 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.
N. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
O. 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.
P. Install shower flow-control fittings with specified maximum flow rates in shower arms.

Q. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
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 20 Section "Basic Mechanical Materials and Methods."
S. Set service basins in leveling bed of cement grout. Grout is specified in Division 20 Section "Basic Mechanical Materials and Methods."
T. 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 7 Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 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. Individual water line branches, waste lines, vents, and traps for connection to individual fixtures, fixture fittings and specialties shall be in accordance with the schedule on the Drawings.
D. Ground equipment according to Division 26 Section "Grounding and Bonding."
E. Connect wiring according to Division 26 Section "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.

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, or cartridges of leaking and dripping faucets and stops.

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 22 4200

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SECTION 22 4500 -
EMERGENCY 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers and water filters.
4. Division 22 Section "Drainage Piping Specialties" for floor drains and cleanouts.

1.2 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Tepid: Moderately warm.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
C. ASSE Standard: Comply with ASSE 1071 “Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment” for emergency mixing valves.
D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
E. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 COMBINATION UNITS

A. Combination Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Bradley Corporation; S19314 Series.
b. Guardian Equipment Co.
c. Haws Corporation.
d. Speakman Company.
e. Stingray Systems.
2. Description: Plumbed, accessible, freestanding, with emergency shower and eyewash equipment.
a. Piping: Galvanized steel.
1) Unit Supply: NPS 1-1/4 minimum from top or side.
2) Unit Drain: Outlet at side near bottom.
3) Shower Supply: NPS 1 with flow regulator and stay-open ball valve.
4) Eyewash Supply: NPS 1/2 with flow regulator and stay-open ball valve.
b. Shower Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
1) Valve Actuator: Pull rod.
2) Shower Head: 8-inch minimum diameter, chrome-plated brass or stainless steel.
c. Eyewash Equipment: With capacity to deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
1) Valve Actuator: Paddle and Treadle.
2) Receptor: Stainless-steel bowl.

2.2 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Acorn Controls; Morris Group International; ET71 Series.
b. Armstrong International, Inc. (RADA)
c. Bradley Corporation.
d. Guardian Equipment Co.
e. Haws Corporation.
f. Lawler Manufacturing Co., Inc.; Model 911 E.
g. Leonard Valve Company.
h. Powers, a Watts Industries Co.; Model ES 200.
i. Speakman Company.
j. Stingray Systems; SV125.
2. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.

a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at a single emergency eye/face wash and drench shower unit, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

2.3 SOURCE QUALITY CONTROL

A. Certify performance of emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
B. Install fixtures level and plumb.
C. Fasten fixtures to substrate.
D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section "General Duty Valves for Plumbing."
   1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
E. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 20 Section "Basic Mechanical Materials and Methods."
F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Thermometers are specified in Division 20 Section "Meters and Gages."
G. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.
H. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system. Drainage piping is specified in Division 22 Section "Sanitary Waste and Vent Piping."
I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 20 Section "Basic Mechanical Materials and Methods."
J. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment. Identification materials are specified in Division 20 Section "Mechanical Identification."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.
C. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.

D. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary or storm drainage piping.

3.4 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.
B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
C. Report test results in writing.

3.5 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.
B. Adjust equipment temperature settings.

END OF SECTION 22 4500

SECTION 22 4700
DRINKING FOUNTAINS, WATER COOLERS, AND CUSPIDORS

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.
B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 DEFINITIONS

A. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.
B. Cast Polymer: Dense, cast-filled-polymer plastic.
C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
D. Fitting: Device that controls flow of water into or out of fixture.
E. Fixture: Drinking fountain or water cooler.
F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.
G. TDS: Total dissolved solids.
H. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.3 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For fixtures to include in emergency, 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 NRTL acceptable to authorities having jurisdiction, and marked for intended use.
B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" for fixtures for people with disabilities.
C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
D. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
E. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PRESSURE (ELECTRIC) WATER COOLERS

A. Water Coolers, EWC-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkay Manufacturing Co.; Model EZO8WSSK.
      b. Halsey Taylor.; Model HTHB-HAC8SS-NF.
   2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult mounting height with bottle filler without filter.
      a. Cabinet: Single, all stainless steel with stainless-steel top, and single filtered cooler with bottle filling station.
      b. Bubbler: One, flexible or elastomeric overmolded, with adjustable stream regulator, located on each cabinet deck.
      c. Control: Hands free for BOTH the bottle filler and the bubbler.
      d. Supply: NPS 3/8 with ball, gate, or globe valve.
      e. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
      f. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
         1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
         2) Electrical Characteristics: 1/5 hp; 120-V ac; single phase; 60 Hz.
      g. Bottle Filling Station: Recessed design constructed of 18 gage Type 300 series stainless steel and ABS plastic. Include:
         1) Electronic sensor for no-touch activation.
         2) Automatic 20-second shut-off timer.
         3) 1.1 gpm flow rate.
         4) Anti-microbial protected plastic components.
      h. Support: Refer to "Fixture Supports" Article.

2.2 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
   3. Tyler Pipe; Wade Div.
   4. Smith, Jay R. Mfg. Co.
   5. MIFAB Manufacturing, Inc.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
   1. Type I: Hanger-type carrier with two vertical uprights.
   2. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

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. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 20 Section "Valves."
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 20 Section "Basic Mechanical Materials and Methods."
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 7 Section "Joint Sealants."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 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."
D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
   1. Remove and replace malfunctioning units and retest as specified above.
   2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.
B. Adjust water cooler temperature settings.

3.7 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 22 4700

SECTION 23 0500
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 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 23 Section “Testing, Adjusting, and Balancing.”

1.2 SUMMARY

A. This Section includes common requirements for fans and air moving equipment.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Fan bearings.
   2. V-belt fan drives.
   3. Direct drive couplings.

1.4 QUALITY ASSURANCE

A. Electrical Characteristics for HVAC 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.

B. Fan Performance Data: AMCA Standard 210.

C. Sound Power Level Ratings:
   1. Ducted Fans - Rated per AMCA 301, when tested per AMCA 300.
   2. Nonducted Fans - Rated in Zones at 5 feet from acoustic center of fan rated per AMCA 301, tested per AMCA 300 and converted per AMCA 302.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

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 FAN SHAFTS

A. Fan Shafts: Ground from solid cold rolled steel, and proportioned to run at least 25 percent below the first critical speed.

2.3 FAN POWER TRANSMISSION

A. V-Belt Type Fan Drives: In accordance with Engineering Standard Specification for Drives Using Multiple V-Belts, sponsored by the Mechanical Power Transmission Association and the Rubber Manufacturer's Association.

B. A given manufacturer's V-belt drive, as applied to specific equipment provided under the Contract, shall conform to the equipment manufacturer's published recommendations, except as otherwise specified.

C. Base horsepower rating of drive on minimum pitch diameter of small sheave.

D. Locate belt drives outboard of bearings. Align drive and driven shafts by the four-point method.

E. Adjust belt tension in accordance with the manufacturer's recommendations.

F. Perform alignment and final belt tensioning in the presence of the Architect.

2.4 SHEAVES

A. Furnish sheaves of machined cast iron or carbon steel, bushing type of fixed bore, secured to the shaft by key and keyway.

B. For all constant speed fans at or above 2 inches of total static pressure, Contractor shall provide and install two sets of fixed sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after system balance is complete and shall be based on actual field conditions.

C. For all constant speed fans below 2 inches total static pressure, Contractor shall provide and install two sets of adjustable sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after the balance is complete and shall be based on actual field conditions, and selected at mid-range of the sheave.

D. Set pitch diameters of fixed pitch and adjustable or variable pitch sheaves when adjusted as specified, at not less than that recommended by NEMA Standard MG1-14.42.

E. For companion sheaves for adjustable or variable pitch drives, furnish wide groove spacing to match driving sheaves.
F. For all variable frequency controller (VFC) operated fans, contractor shall provide and install one set of fixed sheaves sized to allow full utilization of fan motor horsepower provided, with VFC at 100 percent of fan motor RPM.

2.5 V-BELT FAN DRIVES

A. Fan Drives: Multiple V-belt style with adjustable pitch driver sheaves for fans up to 2 inches of total static pressure and fixed pitch driver sheaves for fans at or above 2 inches of total static pressure and up. Sheaves shall have split, taper style bushings. Drives shall be selected for a 150 percent service factor and shall provide for adjustment of both belt tension and alignment.
B. Manufacturers:
   1. Emerson Power Transmission; Browning.
   2. Rockwell Automation; Dodge.
   3. T.B. Wood's Incorporated.

2.6 FAN DRIVE, SHAFT, AND COUPLING GUARDS

A. Safety Provisions: Include guards and screens for power transmission equipment, but do not negate vibration isolation provision.
B. Furnish ANSI and OSHA compliant mechanical power transmission apparatus guards except where superseded by other governing codes, and except as modified and supplemented. Requirements specified apply to all types of fans.
C. Fabricate mechanical power transmission device guards such that the completed structure is capable of withstanding a load of at least 200 pounds applied in any direction.
D. Furnish a guard enclosure for each V-belt drive, coupling, shaft, and rotating component. Secure guards in place, easily removable for maintenance. Guard fasteners used for maintenance access shall be "captive type." Locate holes on each guard for tachometer readings on both the motor and fan shafts. Fabricate guard of minimum 16 gage sheet metal with hemmed edges at openings for shafts. Weld four mounting lugs or feet of 10 gage material to the guard. Fabricate guards for couplings five inches in diameter and larger of 12 gage sheet metal. Furnish holes in mounting feet sized for suitable machine screws.
E. Centrifugal exhaust fans shall be provided with shaft seals.

2.7 BELT DRIVE GUARDS

A. Belt Guards: ANSI and OSHA compliant with provision for readily viewing belt tension and measuring shaft speeds. Guards shall be installed with quick release pins, so that removal of three to five clip pins, will allow the guard to be removed from fan housing.
B. Fabricate guards which completely enclose moving parts of the particular drive. Design and construct guards of such rigidity as to contain a belt which breaks during operation. Minimum material thickness, 16 gage sheet metal. Where ventilation is required, perforated metal shall be used for the sides. Fabricate top of solid sheet metal.

2.8 V-BELTS

A. Notched or cogged style, endless type, of Dacron reinforced elastomer construction, with cross-section to suit sheave grooves. Determine the number of V-belts from the motor horsepower to which apply the service factor to obtain the design horsepower. Determine the corrected horsepower per belt by multiplying the nominal horsepower per belt by an arc of contact factor not greater than 0.85. Divide the design

horsepower by the corrected horsepower per belt to obtain the number of belts required. In any case, furnish not less than two belts for each drive.

B. Furnish belts that have been factory or factory-authorized distributor matched and measured on a belt-matching machine. Selection by "code numbers," "sag numbers" or "match numbers" is not acceptable. Bind each belt set with wire and tag with equipment identification.

C. Manufacturers:
   1. Emerson Power Transmission; Browning; AX, BX, and CX Series and 3VX and 5VX Series.
   2. Rockwell Automation; Dodge; Classic Cog and Narrow Cog V-Belts.
   3. T.B. Wood's Incorporated; Classical Cog and Narrow Cog V-Belts.

2.9 AIR HANDLING SYSTEM BALANCING PROVISIONS

A. Provide extra sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each air handling system during air quantity balancing operations. Furnish sheaves as specified in this Section.

B. Provide sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each existing air handling system requiring rebalancing during air quantity balancing operations. Furnish sheaves as specified in this Section.

2.10 FLEXIBLE COUPLINGS (DIRECT DRIVE)

A. Fan shaft shall be connected to the motor shaft through a flexible coupling. The flexible member shall be a tire shape, in shear, or a solid mass serrated edge disc shape, made of chloroprene materials and retained by fixed flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration or end thrust.

B. Manufacturer:
   1. Falk Corporation (The).

2.11 MOTOR REQUIREMENTS

A. Furnish motors in accordance with Division 20 Section "Motors."

2.12 FAN BEARINGS

A. Bearings: Anti-friction ball or roller type with provision for self-alignment and thrust load. Made in U.S.A. with ABMA L_{10} minimum life of 200,000 hours. Use cast iron housings and dust-tight seals suitable for lubricant pressures.
   1. Lubrication Provisions - Use surface ball check type supply fittings. Provide extension tubes to allow safe maintenance while equipment is operating. Provide manual or automatic pressure relief fittings to prevent overheating or seal blow-out due to excess lubricant or pressure. Arrange relief fittings opposite supply but visible for normal maintenance observation.
   2. Bearings on Equipment with less than 1/2 horsepower rating or on shafts smaller than 1-3/4 inch in diameter: Permanently sealed, pre-lubricated anti-friction bearings per specified materials and ABMA L_{10} life requirements.

2.13 IDENTIFICATION

A. Nameplate: Affix metallic, corrosion-resistant data plate for each fan in a conspicuous location. Include selection point capacity conditions.

2.14 ACCESSORIES

A. Bird Screens: Of material to match adjacent contact construction, 1/2 inch mesh or equal expanded metal. Use on inlet or outlet of each non-ducted fan.

2.15 CUSTOM HEAVYDUTY COMMERCIAL GRADE FILTER SYSTEM

A. Provide custom heavy duty commercial grade filter system including mesh fabric, fasteners, and installation.
B. Mesh fabric shall be constructed with one layer of black PVC-coated polyester high-abrasion media, encased in a sewn vinyl edge with single or double stitching and attached via stainless steel grommets. This media meets NFPA-701 Flame Resistance.
C. The filter shall have less than .05 in. w.g. initial resistance to air flow, depending on the filter media and number of layers required.
D. Filter media shall be heat stabilized, will not shed fibers, absorb moisture or promote bacterial growth.
E. The inherent electrostatic charge of woven polypropylene (BHC) media delivers a higher particle arrestance efficiency and enhanced ability to capture and hold smaller particles.
F. Customized to meet any equipment air intake or ventilation inlet and outlet challenge – including those requiring pipe and electrical cut-outs, special shapes and skirting where grommet attachment to the metal enclosure is not possible. Hook/loop or magnets can be added to completely seal air bypass.
G. Suppliers:
H. Aero Filter, Inc. (248-837-4100)
I. Air Solutions Company (1-800-819-2869)
J. Permatron (1-800-882-8012)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field Rigging: Do not negate balancing. Do not bend shaft. Use lifting eyes.
B. Install sheaves where recommended by Testing, Adjusting, and Balancing agency.
C. Refer to individual Division 23 HVAC equipment Sections for additional requirements.

END OF SECTION 23 0500

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SECTION 23 0523
GENERAL-DUTY VALVES 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.

B. Related Sections include the following:
   1. Division 20 Section "Mechanical Identification" for valve tags and charts.
   2. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
   3. Division 22 Section “General-Duty Valves for Plumbing” for plumbing valves.
   4. Division 23 Section "Temperature Controls" for control valves and actuators.

1.2 SUMMARY

A. This Section includes valves for general HVAC applications. Refer to piping Sections for specialty valve applications.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. NBR: Acrylonitrile-butadiene rubber.
   4. NRS: Nonrising stem.

5. OS&Y: Outside screw and yoke.
6. PTFE: Polytetrafluoroethylene plastic.
7. RPTFE: Reinforced polytetrafluoroethylene plastic.
8. SWP: Steam working pressure.
9. TFE: Tetrafluoroethylene plastic.
10. WOG: Water, oil, and gas.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.
B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

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. Set butterfly valves closed or slightly open.
   6. 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 VALVES, GENERAL

A. Isolation valves are scheduled on the Drawings. For other general HVAC valve applications, use the following:
   1. Throttling Service: Angle, ball, butterfly, or globe valves.
   2. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.
B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
D. For valves not indicated in the Application Schedules, select valves with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water, heating hot water, steam, and steam condensate services.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 and Smaller: Threaded ends.

5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End Systems: Valve ends may be grooved. Do not use for steam or steam condensate piping.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
G. Valve Actuators:
   1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
   2. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
   3. Handwheel: For valves other than quarter-turn types.
   4. Lever Handle: For quarter-turn valves NPS 6 and smaller.
H. Extended Valve Stems: On insulated valves.
I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
J. Valve Grooved Ends: AWWA C606.
K. Solder Joint: With sockets according to ASME B16.18.
   1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.
L. Threaded: With threads according to ASME B1.20.1.
M. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.
B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.; Series 70-140.
      b. Crane Co.; Crane Valves.
      c. Hammond Valve.
      d. Milwaukee Valve Company; Model BA100S.
      e. NIBCO INC.; Models S-580-70-66 or T-580-70-66.
      f. Watts Water Technologies, Inc.

2.3 GENERAL SERVICE BUTTERFLY VALVES

A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:
   1. Full lug, and grooved valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange.
   2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.
B. Lug-Style (Single-Flange) Size NPS 2-1/2 through NPS 12 , 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat (liner).
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD 145.
b. Bray International, Inc.
c. DeZurik.
d. Forum Energy Technologies; ABZ Valve.
e. Hammond Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.; LD-2000-3/5.
h. Pentair Valves & Controls; Keystone.
i. Tyco Flow Control; Grinnell Flow Control.
j. Watts Water Technologies.

2.4 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.
B. Class 150, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.
      b. Crane Co.; Crane Valves.
      c. Crane Co.; Stockham Div.
      d. Hammond Valve.
      e. Milwaukee Valve Company; Model 515.
      f. NIBCO INC.; Models S-433-B or T-433-B.
      g. Watts Water Technologies.

2.5 IRON SWING CHECK VALVES

A. Iron Swing Check Valves, General: MSS SP-71.
B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.
      b. Crane Co.; Crane Valves.
      c. Crane Co.; Stockham Div.
      d. Hammond Valve.
      e. Milwaukee Valve Company; Model F-2974.
      f. NIBCO INC.; Model F-918-B.
      g. Watts Water Technologies.
C. Class 250, Gray-Iron, Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; and bronze disc and seat; and having 500 psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.
      b. Crane Co.; Crane Valves.
      c. Crane Co.; Stockham Div.
      d. Hammond Valve.
      e. Milwaukee Valve Company; Model F-2970.
      f. NIBCO INC.; Model F-968-B.
      g. Watts Water Technologies.
D. Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends; nonasbestos, synthetic-fiber gaskets; rubber seats; and having 250-psig CWP Rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Mueller Co.
    b. NIBCO, INC.; Model G-917-W.
    c. Tyco Fire & Building Products; Grinnell Mechanical Products.
    d. Victaulic Co. of America.

2.6 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic TFE Disc:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Hammond Valve.
        b. Milwaukee Valve Company.
        c. NIBCO INC.; Model S-480-Y or T-480-Y.
        d. The Wm. Powell Company.
    2. Description:
        a. Standard: MSS SP-80, Type 2.
        b. CWP Rating: 250 psig.
        c. Body Design: Vertical flow.
        d. Body Material: ASTM B 584 Alloy C844, bronze.
        e. Ends: Threaded or Solder.
        f. Disc: PTFE, or TFE.

2.7 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK VALVES

A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.
B. Class 125, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 200 psig CWP rating.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. NIBCO INC.; Model W-910-B.
        b. Mueller Steam Specialty.
        c. Milwaukee Valve Company.
        d. Hammond Valve.
C. Class 250, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 400 psig CWP rating.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. NIBCO INC.; Model W-960-B.
        b. Mueller Steam Specialty.
        c. Milwaukee Valve Company.
        d. Hammond Valve.
D. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 200 psig CWP rating.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. NIBCO INC.; Model F-910-B.
        b. Mueller Steam Specialty.
        c. Milwaukee Valve Company.
        d. Hammond Valve.
E. Class 250, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 400 psig CWP rating.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. NIBCO INC.; Model F-960-B.

b. Mueller Steam Specialty.
c. Milwaukee Valve Company.
d. Hammond Valve.

2.8 BRONZE GLOBE VALVES

A. Bronze Globe Valves, General: MSS SP-80, with malleable-iron handwheel.
B. Class 150, TFE Disc, Bronze Globe Valves: ASTM B-62 bronze body, bonnet, and seat, TFE disc, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 300 psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.
      b. Crane Co.; Crane Valves.
      c. Hammond Valve.
      d. Milwaukee Valve Company; Model 590.
      e. NIBCO INC.; Models S-235-Y or T-235-Y.
      f. Watts Water Technologies, Inc.

2.9 CAST-IRON GLOBE VALVES

A. Cast-Iron Globe Valves, General: MSS SP-85 with bolted bonnet, flanged end connections, and non-asbestos packing and gasket.
B. Class 125, Metal Seat, Cast-Iron Globe Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim and having 200 psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.
      b. Crane Co.; Crane Valves.
      c. Crane Co.; Stockham Valves.
      d. Hammond Valve.
      e. Milwaukee Valve Company; Model F-2981.
      f. NIBCO INC.; Model F-718-B.
      g. Watts Water Technologies, Inc.

2.10 BRONZE ANGLE VALVES

A. Bronze Angle Valves, General: MSS SP-80, with silicon bronze stem, non-asbestos packing and malleable-iron handwheel.
B. Class 150, Bronze Angle Valves: ASTM B 62 bronze body with TFE disc, union-ring bonnet, threaded ends, and having 300-psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valves.
      b. Crane Co.; Stockham Valves.
      c. Hammond Valve.
      d. Milwaukee Valve Company; Model 595T.
      e. NIBCO INC.; Model T-335-Y.
      f. The Wm. Powell Company.

2.11 CAST-IRON ANGLE VALVES

A. Cast-Iron Angle Valves, General: MSS SP-85, Type II; having ASTM A 126, Class B cast-iron body and bolted bonnet; bronze mounted, non-asbestos packing and gaskets; and flanged-end connections.
B. Class 125, Cast-Iron, Standard Angle Valves: 200-psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. NIBCO INC.; Model F-818-B.

b. Crane Co.; Stockham Valves.
c. Crane Co.; Crane Valves.

2.12 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
   1. Bronze ball valve as specified in this Section.
   2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.13 CHAINWHEEL ACTUATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Babbitt Steam Specialty Co.
   2. Roto Hammer Industries, Inc.
B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
   2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.
B. 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.
C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
D. Examine threads on valve and mating pipe for form and cleanliness.
E. 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.
F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
C. Locate valves for easy access and provide separate support where necessary.
D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.
E. Install valves in position to allow full stem movement.
F. Install chainwheel operators on valves NPS 4and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor elevation.
G. 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 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 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 23 0523

SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING

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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 23 Section “Common Work Results for HVAC.”

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing to produce design objectives for the following:
   1. Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.

2. Hydronic Piping Systems:
    a. Constant-flow systems.
    b. Variable-flow systems.
    c. Primary-secondary systems.
3. HVAC equipment quantitative-performance settings.
4. Exhaust hood airflow balancing.
5. Verifying that automatic control devices are functioning properly.
6. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
B. AHJ: Authority having jurisdiction.
C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
F. NC: Noise criteria.
G. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
H. RC: Room criteria.
I. Report Forms: Test data sheets for recording test data in logical order.
J. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
K. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
L. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
M. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
N. TAB: Testing, adjusting, and balancing.
O. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
P. Test: A procedure to determine quantitative performance of systems or equipment.
Q. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3.
C. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
B. Approved Balancing Agencies.
   1. The TAB firm selected shall be from the following list:
      a. Airflow Testing Inc.; Lincoln Park, MI.
      b. Control Solutions Inc; Byron Center, MI.
      c. Enviro-Aire/Total Balance Co.; St. Clair Shores, MI.
      d. Absolut Balance Company, Inc.; South Lyon, MI.
      e. Air Solutions, Inc.; Lapeer, MI.
      f. Barmatic Inspecting Co., Inc.; Lincoln Park, MI.
      g. Ener-Tech Testing; Holly, MI.
      h. International Test & Balance, Inc.; Southfield, MI.
      i. Quality Air Service; Portage, MI.
C. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items: Include at least the following:
      a. Submittal distribution requirements.
      b. The Contract Documents examination report.
      c. TAB plan.
      d. Work schedule and Project-site access requirements.
      e. Coordination and cooperation of trades and subcontractors.
      f. Coordination of documentation and communication flow.
D. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
E. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." TAB firm's forms approved by Architect.
F. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
G. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

A. 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. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
B. Notice: Provide seven days advance notice for each test. Include scheduled test dates and times.
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: If AABC standards are used, 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.
B. Special Guarantee: If NEBB standards are used, provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include 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 system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
B. Examine system and equipment test reports.
C. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
D. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
E. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
F. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
G. Examine strainers for clean screens and proper perforations.
H. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
J. Examine system pumps to ensure absence of entrained air in the suction piping.

K. Examine equipment for installation and for properly operating safety interlocks and controls.
L. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
   6. Sensors are located to sense only the intended conditions.
   7. Sequence of operation for control modes is according to the Contract Documents.
   8. Controller set points are set at indicated values.
   9. Interlocked systems are operating.
   10. Changeover from heating to cooling mode occurs according to indicated values.
M. 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. Perform the following field tests and inspections to new and renovated portions of duct systems according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
   1. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
   2. Maximum Allowable Leakage: Leakage rates are scheduled on the Drawings.
C. Complete system readiness checks and prepare system readiness 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 Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
B. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position

indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

C. Take and report testing and balancing measurements in inch-pound (IP) 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, or use reduced scale contract documents with notations.

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. Cut insulation, and drill ducts for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes with neat patches, neoprene plugs, threaded plugs, or threaded twist-on metal caps, and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

F. Check air flow within intake plenums and mixing boxes of air handling units for uneven flow and temperature stratification and prepare a report with profile elevations (temperature and velocity) on each coil or filter face for Architect.

G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

H. Verify that motor starters are equipped with properly sized thermal protection.

I. Check dampers for proper position to achieve desired airflow path.

J. Check for airflow blockages.

K. Check condensate drains for proper connections and functioning.

L. Check for proper sealing of air-handling unit components.

M. Check for proper sealing of air duct system.

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 fan static pressures to determine actual static pressure as follows:
    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from 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.
2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Select required sheave sizes and advise installing contractor to change drive sheaves accordingly. Refer to Division 23 Section “Common Work Results for HVAC” for additional requirements.
5. When existing air handling systems require rebalancing, select required sheave sizes and advise Mechanical Contractor to change drive sheaves accordingly.

Refer to Division 23 Section “Common Work Results for HVAC” for additional requirements.

6. Do not recommend 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 modes 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 at a point downstream from the balancing damper and adjust volume dampers until the proper airflow is achieved.
      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. 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 terminal 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 terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using 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 maximum set-point 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 outside-air dampers at minimum, and 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 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 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.
      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 outside airflow. Adjust the fan and balance the return-air ducts and inlets 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 the 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 approved pump flow rate.
B. Prepare schematic diagrams of systems' "as-built" piping layouts, or use reduced scale contract documents with notations.
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 expansion tank liquid level.
   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 system controls so automatic valves are wide open to heat exchangers.
   6. 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.
   7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

3.8 PROCEDURES FOR 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.
   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.
   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 5 percent of design.
B. Set calibrated balancing valves, if installed, at calculated presettings.
C. 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.
D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
E. 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.

F. Equipment installed with pressure independent characterized control valves (PICCV) or auto-flow devices shall not require hydronic system balancing unless multiple coils are served from a single PICCV or auto-flow device (Example: AHU coil banks with multiple coils). Measure flow through each PICCV and auto-flow device and compare measured value to scheduled value to verify proper valve/device was installed and valve is functional. Verify flow for 100 percent of PICCV and auto-flow devices. Report discrepancies.

G. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

H. Measure the differential-pressure control valve settings existing at the conclusions of balancing, and record in report.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance variable-flow hydronic systems by following the “Proportional Balancing Procedure” in accordance with NEBB.

B. 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-SECONDARY-FLOW HYDRONIC SYSTEMS

A. Balance the primary system crossover flow first, then balance the secondary system.

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. Record inlet steam pressure.

E. Record settings of safety and relief valves.

3.12 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Power factor.
6. Nameplate and measured voltage, each phase.
7. Nameplate and measured amperage, each phase.
8. Starter size.
9. Starter thermal-protection-element rating.
10. Fuse number and size.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.13 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.14 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each 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. Steam Coils: Measure the following data for each coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Airflow.
   3. Air pressure drop.
   4. Inlet steam pressure.

C. Refrigerant Coils: Measure the following data for each 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.

3.15 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.16 PROCEDURES FOR EXHAUST HOODS

A. Measure, adjust, and record the airflow of each exhaust hood. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, explain why, in the report, and explain the test method used.

B. After balancing is complete, do the following:
   1. Measure and record the static pressure at the hood exhaust-duct connection.
   2. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to achieve optimum results.

3.17 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Air handling equipment and outlets: Plus or minus 5 percent.
      a. Where terminal units serve 6 or more outlets within a common room, individual outlets may vary up to plus or minus 10 percent of design flow rates if overall room supply is within plus or minus 5 percent.
   2. Heating-Water Flow Rate: 0 to minus 10 percent.
   3. Cooling-Water Flow Rate: 0 to plus 5 percent.

3.18 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: As Work progresses, prepare 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.

3.19 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.

C. 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, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   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 firm 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. Notes to explain why certain final data in the body of reports varies from indicated values.
   14. Test conditions for fans and pump performance forms including the following:
      a. Settings for outside-, 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.

E. 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 outside, supply, return, and exhaust airflows.
2. Water flow rates.
3. Terminal units.
4. Balancing stations.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
   1. Unit Data: Include the following:
      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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
      j. Number of belts, make, and size.
      k. Number of filters, type, and size.
   2. Motor Data:
      a. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
      g. Power factor efficiency.
   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. 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. Outside airflow in cfm.
      j. Return airflow in cfm.
      k. Outside-air damper position.
      l. Return-air damper position.
      m. Vortex damper position.

G. 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. Airflow rate in cfm.
      b. Average face velocity in fpm.
      c. Air pressure drop in inches wg.

d. Outside-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.

H. 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 airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device effective area in sq. ft.
2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. 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. Airflow 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.

K. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and type.
      e. Model and serial numbers.
      f. Ratings.
   2. Steam Test Data (Indicated and Actual Values):
      a. Inlet pressure in psig.
      b. Condensate flow rate in lb/h.
   3. Primary Water Test Data (Indicated and Actual Values):
      a. Entering-water temperature in deg F.
      b. Leaving-water temperature in deg F.
      c. Entering-water pressure in feet of head or psig.
      d. Water pressure differential in feet of head or psig.
      e. Water flow rate in gpm.
   4. Secondary Water Test Data (Indicated and Actual Values):
      a. Entering-water temperature in deg F.
      b. Leaving-water temperature in deg F.
      c. Entering-water pressure in feet of head or psig.
      d. Water pressure differential in feet of head or psig.
      e. Water flow rate in gpm.

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 and serial numbers.
      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.

3.20 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. Randomly check the following for each system:
a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Measure space pressure of at least 10 percent of locations.
e. Verify that balancing devices are marked with final balance position.
f. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
1. After initial inspection is complete and evidence 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.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The 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 the 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.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.21 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing 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 testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 23 0593

SECTION 23 0933
TEMPERATURE CONTROLS

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 of this section.
B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

A. BAS: Building Automation System
B. CAD: Computer Aided Design.
C. DDC: Direct-digital controls.
D. TC: Temperature Control.

1.4 SYSTEM DESCRIPTION

A. Temperature control building automation system consisting of direct digital control system panels, sensors, transducers, relays, switches, data communication network, etc. and all associated control wiring and raceway systems.
B. BAS/DDC system programming, database and coordination with MCC’s Master Systems Integrator responsible to develop graphic display generation at the existing Tridium Supervisory Server.
C. Electric thermostats, control valves, dampers, operators, control wiring, etc.
D. Gauges, indicating devices, electric and electronic control accessories, and other control system devices.
E. Building Network Supervisory Control Panel as indicated on the drawings.

1.5 TEMPERATURE CONTROLS BUILDING INTEGRATION REQUIREMENTS

A. The owner has selected Knight Watch Inc. as their qualified Master System Integrator for the building automation system (BAS) that shall be known herein as the “Integrator”. The Integrator’s scope of work shall be contracted direct to Macomb Community College (MCC) unless MCC coordinates otherwise with project’s Construction Manager.
B. Temperature Controls (TC) contractor shall cooperate with the Integrator to provide a complete and operable BAS Owner Interface. TC contractor shall be responsible to integrate various building systems and equipment as indicated to Network Area Controller(s), aka JACE(s), that shall be provided by TC contractor and be connected to the BAS. TC contractor shall coordinate point databases for integration with the various building systems and equipment suppliers to accommodate appropriate monitoring and control for the building. Blocks required for supervisory level scheduling functions, trending, alarm monitoring and routing shall be configured by the TC contractor. Refer to the construction drawings and other specification sections for systems and equipment to be integrated.
C. TC contractor is responsible for all the building controllers, programming, required JACEs, and control integration and field wiring for packaged control equipment associated with the project. Integrator is to coordinate with MCC personnel to

develop system point naming conventions, standard points to trend including frequency and standard alarms that shall be coordinated with TC contractor.

D. The TC contractor is required to attend meetings with the Integrator and associated subcontractors and equipment suppliers as necessary to facilitate integration of the building systems and equipment into the BAS. Include a minimum of forty (40) hours in TC contractor Bid allocated to these meetings. Include this item in your Scope of Work summary.

E. The intent is to provide a peer-to-peer networked standalone, distributed control system with the capability to integrate ANSI/ASHRAE standard 135-2001 BACnet technology, MODBUS and other open and proprietary communication protocols into one open, interoperable system.

F. BACnet devices shall be via Ethernet (BACnet Ethernet/IP), and/or RS-485 (BACnet MSTP) as specified. When IP controllers are utilized, the controls contractor shall install an operation technology network within the building. Only one IP address is allowed for interface to the server platform per building.

G. A point integration checklist for each device (TC contractor provided controllers and packaged equipment controllers) must be submitted by the TC contractor to the Integrator. The integration checklist form for defined required data is provided by the Integrator. TC Contractor shall duplicate these, document each controller's interface and return them to the Integrator for review.

H. Additional requirements:
   1. TC contractor shall utilize point naming conventions as provided by the Integrator that shall be reviewed with Integrator at coordination meetings.
   2. TC contractor shall provide credentials for the platform and the station to the Integrator.
   3. TC contractor shall provide unitary code residing in controllers to the Integrator and Macomb Community College.

I. The Integrator is responsible for graphics development. The Integrator shall provide graphical representation and supervision of energy management, temperature controls via DDC controls provided by TC contractor under this Section, controllers provided by equipment suppliers under Division 23 specifications and other monitored building systems as shown in Construction Documents.

J. Confirm Vykon Network Supervisory Controller (JACE) licenses are set as "Open" and licensed to Macomb Community College. Verify that Network Supervisory Controller capacity allows 15% additional device/point capacity.

1.6 SEQUENCE OF OPERATION

A. Control sequences for HVAC systems, subsystems, and equipment are indicated on project drawings.

1.7 SUBMITTALS

A. Submit under Division 20 and 23 provisions of respective project and as supplemented in this section.

B. All control submittal requirements shall be submitted at one time with exception to control valves, automated dampers, and initial phases of work associated with fast-track projects (when required). Early submittals of control valve and automated dampers shall be incorporated with the complete temperature controls submittal.

C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. Each control device labeled with setting or adjustable range of control

D. 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.
E. Shop Drawings:
   1. Shop drawings shall be done on CAD. Minimum size 11” x 17”.
   2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
   4. Details of control panel faces and interior, including controls, instruments, termination blocks and labeling.
   5. Written sequence of operation for each controlled system.
   6. Schedule of dampers including size, leakage, and flow characteristics (Refer to Design Data).
   7. Schedule of valves including leakage and flow characteristics (Refer to Design Data).
   8. Complete bill of materials to identify and quantify all control components
   9. Overall system schematic showing communication trunk cabling to DDC panels, peripheral devices, modems including component locations and wire termination details.
   10. DDC panel layouts showing connected data points and LAN connections. DDC panel terminations including power supply and remote control component termination details shall be provided.
   11. Point list for each DDC panel including point descriptions and addresses. This information may be incorporated with DDC panel layouts.
   12. List of system graphics to be provided with proposed tree diagram of graphics organization. Items to include: Each system, floor plan.
F. Graphic Displays: One month after TC Shop Drawing submittal, TC Contractor shall submit graphical display backgrounds for preliminary Engineer review. Concept for each floor plan, each system, each terminal unit template. Engineer understands that final representation of graphics may not be available until BAS database is established during course of construction. Thorough graphics review will be conducted by Engineer as part of the TC/BAS acceptance procedure. Include campus site plan with 3D building graphic.
G. Design Data: Provide indicated component selection and sizing criteria for the following component categories:
   1. Control valves:
      a. Component tag.
      b. Equipment served/function.
      c. Media type.
      d. Design flow rate (GPM).
      e. Design pressure drop (ft. head) or (psi)
      f. Calculated valve Cv
      g. Selected valve Cv
      h. Resultant pressure drop (ft. head) or (psi) with selected valve.
      i. Valve size.
      j. Line size to valve connection (excluding reducers).
      k. Type (ball, butterfly, globe, etc.).
      l. Configuration (2-way, 3-way mixing, 3-way diverting).
      m. Normal position (normally open, normally closed, floating).
      n. Actuator spring range (where applicable).
      o. Actuator power requirement.
      p. Valve shut-off rating (ft. head) of (psi)
      q. Valve body pressure/temperature rating.

r. Valve manufacturer/model number.
s. Actuator manufacturer/model number.

2. Dampers:
   a. Component tag.
   b. Equipment served/function.
   c. Overall damper size (inch height x inch width).
   d. Quantity of damper sections with respective size(s):
   e. Material and gauge of thickness.
   f. Mounting orientation (horizontal or vertical).
   g. Blade configuration (parallel or opposed)
   h. Pressure drop (in. WG).
   i. Shut-off rating/differential pressure rating (in. wg).
   j. Leakage rating (CFM/sq. ft. at 4 in. wg).
   k. Normal position (normally open, normally closed, floating).
   l. Actuator spring range (where applicable).
   m. Actuator power requirement.
   n. Actuator torque requirement.
   o. Actuator quantity.
   p. Damper manufacturer/model number.
   q. Actuator manufacturer/model number.
3. Flow measuring probes - Air:
   a. Component tag.
   b. Equipment served/function.
   c. Duct dimension (inch height x inch width) if applicable.
   d. Fan inlet diameter (inch) if applicable)
   e. Probe quantity.
   f. Probe length.
   g. Flow rate (CFM).
   h. Flow velocity (FPM).
   i. Probe manufacturer/model number.
   j. Transmitter manufacturer/model number.
4. Flow measuring probes - Water:
   a. Component tag.
   b. Equipment served/function.
   c. Pipe size/inside diameter (inch)
   d. Probe length.
   e. Flow rate (GPM).
   f. Flow velocity (FPS).
   g. Probe manufacturer/model number.
   h. Transmitter manufacturer/model number.
5. Flow measuring stations - Air:
   a. Component tag.
   b. Equipment served/function.
   c. Duct dimension (inch height x inch width).
   d. Station dimension (inch height x inch width).
   e. Flow rate (CFM).
   f. Flow velocity (FPM).
   g. Pressure drop (in. wg).
   h. Station manufacturer/model number.
   i. Transmitter manufacturer/model number.
6. Gauges:
   a. Component tag.
   b. Equipment served/function.
   c. Units/range of scale

H. Samples: Temperature sensor or thermostat cover for each color required and guards if required.
I. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
J. Submit field reports indicating operating conditions after detailed check out of systems at Date of Substantial Completion.
K. Project Record Documents: Include the following:
   1. Revise Shop Drawings to reflect actual installation and operating sequences.
   2. Record actual locations of control components, including control units, thermostats, and sensors.
   3. Submit the electronic files for all as-built shop drawings on diskette in AutoCAD format. Verify AutoCAD version with Owner prior to submittal.
L. Software and Firmware Operational Documentation: Include the following:
   1. DDC panel keypad operating instructions and DDC panel control override features.
   2. Device address list.
   3. Program Software Backup: On a magnetic media or compact disc, complete with data files.
M. Maintenance Manuals: Include the following:
   1. Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.
   2. Keypad illustrations and step-by-step procedures indexed for each operator function.
   3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   4. Calibration records and list of set points.

1.8 REFERENCES

A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
B. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure fittings.
C. ANSI/ASTM B32 - Solder Metal.
D. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
E. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
F. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
G. ASTM B75 - Seamless Copper Tube for General Engineering Purposes.
H. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.
I. NEMA DC 3 - Low-Voltage Room Thermostats.
J. ASTM E1 - Specification for ASTM Thermometers.
K. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics Only.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of the automatic control system manufacturer for both installation and maintenance of units required for this Project.
B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.
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. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

1.10 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated or optional to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.11 COORDINATION

A. Coordinate work under Division 20 and 23 provisions and as supplemented in this section.
B. Coordinate location of space temperature sensors, space humidity sensor, thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
C. Coordinate installation of system components with installation of mechanical systems and equipment to achieve compatibility.
D. Ensure installation of components is complementary to installation of similar components in other systems.
E. Coordinate control wiring requirements, including actual terminal block numbers, with mechanical equipment manufacturers or suppliers.
F. Coordinate equipment with Division 26 Section "Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
G. Coordinate equipment with Division 28 Section "Fire Alarm" to achieve compatibility with equipment that interfaces with that system
H. Ensure control system installation is complete, checked, tested and functioning properly prior to system balancing and Owner/Engineer system checkout.
I. Cooperate fully with the Test and Balance Contractor and provide labor to operate the temperature control system as required to meet the scope of work defined in Division 23 Section "Testing, Adjusting and Balancing."

1.12 WARRANTY

A. Provide warranty per Division 20 Section "General Mechanical Requirements" and as supplemented in this section, and shall include a warranty period of 24 months.
B. Provide 24 hour per day emergency service during warranty period, with maximum response period of four (4) hours. Provide phone number(s) for quick assistance by a Service Engineer regarding hardware or software problems.
C. Provide scheduled maintenance service during warranty period to inspect, calibrate, and adjust controls. Make a minimum of one eight hour service call every three months**.** Notify Owner prior to each scheduled inspection trip. Submit written reports upon completion of service.
D. Provide any software or firmware revisions which are released by the DDC system manufacturer during the warranty period, at no additional cost to the Owner.

1.13 POSTED OPERATING INSTRUCTIONS

A. Provide panel related as-built documents in protective binder or clear plastic display envelope for each control panel. These instructions shall include such items as as-built control diagrams and sequence of operation, simplified narrative instructions and materials necessary to aid in the operation of the equipment at the local control panels.

1.14 SPECIAL TOOLS

A. Deliver two sets of any special tools required for operation, adjustment, resetting or maintenance.

1.15 PROTECTION OF PROPRIETARY INFORMATION

A. All proprietary manuals and software shall be subject to a non-disclosure agreement, to be submitted by the proprietary equipment manufacturer to the Owner for approval and signature during the warranty period.
B. Provide all user names and/or passwords for all control panels.

1.16 PLENUM RATED CABLE

A. Provide low voltage plenum rated control cable above accessible ceilings or within partitions in-lieu-of wire in conduit for these locations. Wiring in Mechanical Rooms and any other exposed areas shall remain installed in conduit.
   1. Plenum rated cable shall be installed in a workmanlike manner, running perpendicular or parallel to the building structure and supported every three to five feet, attached to the building structure, neatly tie wrapped, in bridal rings or other suitable device without sagging.
   2. Do not attach control wiring to ceiling grid hangars, mechanical piping or ductwork.
   3. Wiring shall be protected from chaffing and damage. Identify cable and wire with suitable marking that identifies the cable as “Building Automation System Control Wiring”.

PART 2 - PRODUCTS

2.1 DESCRIPTION OF THE BUILDING AUTOMATION SYSTEM (BAS)

A. The building automation system (BAS) shall be fully integrated, distributed data processing system incorporating direct digital control (DDC) for the control and monitoring of heating, ventilating and air conditioning (HVAC) equipment and other related systems. Microprocessor based BACnet DDC field level panels shall be directly connected to HVAC equipment sensors and actuators. A data communication network shall allow data exchange between the BACnet DDC panels and the Network Controller**.** The Network Controller through web-browser and/or server application software shall serve as the primary operator interface for the BAS. The Tridium Niagara 4 shall be utilized, and provide the N4 software in the full version (Vykon) and provide as a minimum the JACE 8000 with BACnet DDC controllers.
B. Approved Installer (Location):
   1. Conti Controls Group (Sterling Heights, MI).
   2. Knight Watch/Vertex Integration (Hudsonville, MI).
   3. Limbach Company. (Pontiac, MI)
   4. Mechanical Controls & Maintenance, Inc. aka MCMI (Sterling Heights, MI).
   5. Metro Environmental Controls (Clinton Twp, MI).
   6. Siemens / Siemens Building Technologies, Inc. (Plymouth Twp, MI).
   7. Wadsworth Solutions (Southgate, MI).
C. Approved Products:
   1. Graphical User Interface (GUI): Tridium interface communicator, (Vykon) JACE 8000,
   2. JCI-FX series open distribution BACnet Controllers.

2.2 BAS BUILDING NETWORK SUPERVISORY CONTROLLER

A. The Building Network Supervisory Controller shall provide the interface between the Owner’s Ethernet and the field control devices and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
   1. Calendar functions
   2. Scheduling.
   3. Trending.

4. Alarm monitoring and routing.
5. Time synchronization.
6. Integration of BACnet controller data.
7. Network Management functions for all BACnet based devices.

B. The Network Area Controller shall provide the following hardware and driver features as a minimum:
1. One RS-232 port
2. One RS-485 port with BACnet MS/TP Driver.
3. Battery Backup
4. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity).
5. Where the option for expanded memory is available, it must be supplied.

C. Provide BACnet driver(s) as required for system or equipment integration requirements for the project. Provide LON or MODBUS drivers for the Tridium N4 system only if required for interface to 3rd party installed systems.

D. Provide 2-year service agreement per supervisory controller for updating firmware/software as available by manufacturer. Labor for updating the controllers shall be included.

E. Manufacturer:
1. Vykon Niagara 4 JACE-8000 series, sized appropriately per building to handle the required quantity of connected controllers and devices.

2.3 DIRECT DIGITAL CONTROL (DDC) PANELS

A. Control Panels: Modular in design and consisting of stand-alone microprocessor board with ROM and fully custom programmable RAM, EPROM, and/or EEPROM memory, integral interface equipment and power surge protection. DDC panels shall be connected directly to sensors, controlled devices and the communication network.

B. Powerfail Restart and Battery Backup: Minimum of 72 battery backup hours for complete system RAM memory and clock, with automatic battery charger or 48 hour low voltage alarm warning. Upon full system power recovery, all clocks shall be automatically synchronized, and all controlled equipment shall be automatically re-started based on correct clock time and sequence of operation.

C. Uninterruptable Power Supply (UPS): Provide abundant battery backup power to allow the Network controller to work through an extended length power outage for at least four hours. UPS to protect against damaging surges and spikes (transients) that travel along utility and data lines. Include isolated noise filtering. Provide automatic sine wave voltage regulation to instantly adjust for over and under voltages during brownouts and overvoltage conditions. UPS to monitor battery condition and alert the System Operator when battery maintenance is required. Provide a local LCD display to easily read status of utility and battery backup conditions. Provide sealed battery with automatic recharging.
1. Manufacturers: APC by Schneider Electric model S15BLK or equivalent SOLA product.

D. Provide fully functional communication interface ports for communication between processor, other processors, Operator Workstation, portable operator unit and portable programmer terminal.

E. Panel enclosure shall be finished steel or rigid plastic with hinged door and keyed lock. Electronics shall be removable for protection during mounting of panel.

F. Provide LCD or equivalent displays on each panel door (exterior access) to view points and systems.

2.4 DDC PANEL SOFTWARE

A. Operating system shall work in real time, provide prioritized task scheduling, control time programs, monitor DDC panel to DDC panel as well as DDC panel to Operator Workstation communications, scan inputs and outputs, and contain built-in diagnostics.

B. Input/output point processing shall include the following:
   1. Continuous update of input and output values and/or conditions. All connected points are to be updated at least once per second.
   2. Assignment of proper engineering units and status condition identifiers to all points.
   3. In addition to physical or "hardware" points required, "software" points shall be provided where required for command access and meaningful displays, where required by the "execution" portion of this section or where required on the DDC input/output points lists. "Software" points shall appear identical to physical points in output displays and shall be assignable to text descriptors, logical groups, reports, etc. in the same manner as physical points. "Software" points shall be assigned alarm limits in the same manner as physical points.

C. Command control software shall manage the receipt of commands from the Operator Workstation, portable programmers terminal, and from control programs.
   1. Command delay, programmable from 0 to 2 minutes, shall be provided to prevent simultaneous energizing of large loads. Command delays shall be honored throughout the DDC network, not just within the DDC panel. Delays shall be assignable on an individual per point basis.
   2. Each command shall be assigned a command and residual priority to manage contentions created by multiple programs having access to the same command point. Only commands with a higher command priority than the existing residual priority shall be permitted to execute. Whenever a command is allowed to execute, its assigned residual priority shall replace the existing residual priority.
   3. A "fixed mode" option shall be supported to allow inputs to, and outputs from DDC control programs to be set to a fixed state or value. When in the "fixed mode," inputs and outputs shall be so noted in all reports.
   4. A "last user" record is to be maintained to positively identify which program or manual command is in control of a given point. The last user information shall be displayed and printed along with other point data of logical groups.

D. Provide self-test procedure. Notify Operator Workstation for maintenance, performance, software, cable break, or data transmission problems. Identify variables as reliable or unreliable. Variables identified as unreliable shall use default in calculation.

E. Alarm Processing
   1. High/Low Alarm: Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and actual alarm) to an input. Each alarm shall be assigned a unique differential to prevent a point from oscillating into and out of alarm. Alarm comparisons are to be made each scan cycle.
   2. Floating Alarm: Where analog controlled values are automatically varied by software (such as hot water temperature reset), a single set of alarm limits shall be provided for those varying values. These alarm limits shall then "float" a user definable differential above and below the varying setpoint value.
   3. Abnormal Alarm: When a digital input is not in agreement with the commanded state of its associated output point, or when a digital input is not in its normal state, an abnormal alarm shall be generated. Abnormal "on" shall cause an alarm, as well as abnormal "off." Alarm time delay for digital inputs to prevent nuisance alarms shall be provided. Each digital input alarm time delay shall be adjustable from zero to two minutes in one-second increments.

4. Alarm lockout shall be provided to positively lock out alarms when equipment is turned off or when a true alarm is dependent on the condition of an associated point. Lockout points and lockout initiators shall be operator programmable. On initial startup of air handler and other mechanical equipment, a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating alarm comparison logic. Timed lockout period shall be programmable on a per point basis from 0 to 90 minutes in one-minute increments.
5. The capability of automatically initiating commands upon the occurrence of an alarm.
6. Alarm Announcement: Alarms shall announce through the “BAS” to an email or phone (Owners choice) on a real time basis 24 hours a day, 7 days a week. Alarms shall be managed (turned on/off) via the BMS front end (GUI).
    a. Priority “one” alarms shall be specified by the Owner (MCC) and shall announce at the BAS graphical screen and shall phone Norwood Bates mobile phone. Priority one alarms shall include loss of boilers or heating equipment, loss of heating loop temperature or flow and low temperature alarm in the building. Priority one alarms shall be disabled when outside air temperature is above 55 degrees F and by system operator from the BAS system graphic screen.
    b. Priority “two” alarms shall consist of all other alarms not classified as priority “one” alarms. Priority “two” alarms shall announce at the BAS graphical screen.
7. Totalization
8. Run time shall be accumulated based on the status of digital input points. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Run time counts shall be resident in memory and have DDC panel resident run time limits assignable through the portable programmers terminal, portable operators unit or the Operator Workstation. When run time limits are reached, the DDC panel shall issue a report to the Operator Workstation.
9. A transition counter shall be provided to accumulate the number of times a device has been cycled on or off. Counter shall be capable of accumulating 600,000 switching cycles. Limits shall be assignable to counts to provide maintenance alarm printouts.
10. Analog totalization capability shall be provided to allow the totalization of electricity, air, water and steam flow, etc. These flows shall be totalized with respect to time and converted to the appropriate energy unit. It shall be possible to automatically set time intervals for totalization, adjustable from one second to 365 days. The totalization program shall keep track of the maximum and minimum instantaneous analog value measured during the period, including the date and time at which each occurred.

F. Custom DDC Programs
1. All DDC programs shall be fully custom programmable. DDC panels or systems which require remote or factory programming are not acceptable. DDC panels or systems with programs which may not be custom modified by the user are not acceptable. "Custom" programming shall mean allowing the alteration of actual control logic, and shall not be limited to allowing only the alteration of setpoints, gains, parameters, time constants, etc.
2. Custom DDC programs shall be provided to meet the control strategies as called for in the sequences of operation on the drawings.
3. All DDC setpoints, gains, parameters, time constants, etc., associated with DDC programs shall be available to the operator for display and modification via the Operator Workstation and/or portable operators unit.

4. The execution interval of each DDC control loop shall be adjustable from two to 30 seconds.
5. Each DDC panel shall have resident in its memory and available to the programs a full library of DDC algorithms, intrinsic control operators, and arithmetic, logic and relational operators for implementation of control sequences. Functions to be provided shall include, but not be limited to, the following:
    a. Mathematical: Absolute value, calculate, square root, power, sign, average, totalize.
    b. Logic: OR, AND, compare, negate.
    c. Fixed Formula: High and low select, span, rate, ramp, enthalpy, wet bulb, dewpoint, relative humidity, humidity ratio, filter.
    d. Data Manipulation: Store, file and set.
    e. Control Routines: Real-time based functions, proportional control, proportional-integral control, proportional-integral-derivative control, adaptive control (self-tuning), direct-acting, reverse acting, feedforward, fixed setpoint, calculated setpoint, adjustable setpoint, lead lag, hysteresis correction, event initiation/ software interlock.

G. Building Automation System Software
1. The following building automation system application software listed below shall be provided in each DDC panel's memory and shall be available for use within the DDC control programs. Individual application programs shall be capable of being accessed from the Operator Workstation or the portable programmer terminal for enabling/disabling and parameter modification.
2. Time of day scheduling: Allow the creation and maintenance of operating schedules for selected points based on time of day and holiday scheduling. At least two independent start and stop times per day for each system shall be allowed. Each point shall be allowed to have a unique time program, or points shall be able to be grouped and assigned to a common time program. Both digital and analog output points shall be able to be assigned to a time program. This software shall work in conjunction with the time of day scheduler software at the Operator Workstation. This program shall also work in conjunction with the optimum start and optimum stop application software.
3. Optimum Start: Start equipment based on outdoor temperature, space temperature, and system response to minimize energy usage and to assure that comfort conditions are reached exactly at scheduled occupancy time (occupancy schedules are defined under "Time Of Day Scheduling"). This program shall operate in both the heating and cooling cycles. An adaptive algorithm shall be employed which automatically adjusts the start time according to previous performance and shall automatically assign longer lead times for weekend and holiday shutdowns.
4. Economizer Optimization: (dry bulb economizer changeover) Using standard calculations, automatically determine which air source, outdoor air or return air, presents the least total heat load, and automatically adjust mixed air damper position. When outside air exceeds 65 degrees F the outside air damper shall go to its minimum position. Typically, the outside air damper must be in its minimum position before the cooling coil valve is allowed to open.
5. Warm-Up: Position the outside air dampers in an adjustable (minimum) position, and trigger a digital output(s) normally used to signal air terminal units to move to their maximum flow settings. When the desired space temperature is reached, as determined by feedback from space temperature sensor(s), the digital output shall return the air terminal units to their normal operation. When occupancy time is reached, the outside air dampers shall be controlled by the normal occupied mode control sequence. During the warm-up cycle, the outside air damper shall be set at the position which minimizes outside air intake while preventing

over/under pressurizing of ductwork. This program shall work in conjunction with the time scheduling program and/or the optimum start program as required.

6. Night Cycle: Cycle HVAC equipment on and off as required to maintain an operator selectable unoccupied space temperature. During the equipment "on" time, the outside air damper shall be maintained in an adjustable position which minimizes outside air intake while preventing over/under pressurization of ductwork. The equipment shall be cycled such that energy reduction during unoccupied periods is uniform.
7. Night Purge: Night Purge program shall apply to cooling cycle only. Night Purge shall introduce 100% outdoor air any time the outdoor air is above 50 degrees F, the space temperature is above 75 degrees F, the outdoor air temperature is below space temperature and the outdoor air dewpoint is less than 60 deg F. Purging shall stop when outdoor air is below 50 deg F, or space temperature is below 75 deg F, or outdoor temperature is less than 5 deg F cooler than space temperature, or outdoor air dewpoint is greater than 60 deg F.
8. Reset Optimization: Adjust equipment discharge setpoints based on one of the following criteria:
    a. By sensing the worst case requirements (e.g., the zone requiring the most heating or cooling and providing only the minimum energy required to meet the load.
    b. Adjusting the setpoint in direct proportion to another sensed variable (e.g., reset supply water temperature based on outside temperature).

2.5 DDC AIR TERMINAL UNIT CONTROLLERS

A. Microprocessor based controllers capable of stand-alone operation for control of pressure independent air terminal units. Controllers shall be networked together and connected to the building's BAS/DDC network.

B. Controllers shall have separate adjustable minimum and maximum airflow setpoints. Controllers shall work in conjunction with the air handling unit's DDC panel to provide the sequence of operation as indicated on the drawings. Setpoints shall be adjustable through the portable programmer terminal.

C. Provide electronic type air terminal unit damper operators compatible with the controller and the air terminal units provided.

D. Each controller shall have an internal differential pressure transducer capable of utilizing the total and static pressure signals from the air terminal unit's velocity sensor. Velocity sensor shall be furnished by air terminal unit manufacturer.

E. Each controller shall have electronic outputs compatible with the electronically operated air terminal unit tempering coil control valve and perimeter radiation control valve where applicable

F. TC contractor shall provide 24 VAC power requirements including transformers.

G. If coordinated with mechanical contractor. Controllers and damper operators shall be furnished to the air terminal unit manufacturer for factory mounting by the air terminal unit manufacturer; otherwise, controls shall be field installed.

H. Room temperature sensors for the DDC air terminal unit controllers serving non-office spaces:
    1. Sensing Element: Thermistor type or resistance temperature detector (RTD). Accuracy shall be+/- 0.5 degrees F over the range of 55 degrees F to 95 degrees F.
    2. Cover: Brushed stainless steel vandal-resistant flush mounted wall plate type.
    3. Provide with moisture/vapor resistance and sensor bonded to the stainless steel plate.
    4. Provide sensing unit with insulated back that reduces the conductive influences of wall temperatures, yet allows significant convective influences to be sensed.

5. Provide unit mounting with tamper proof security screws. Mount unit on electrical handy box and insulate or seal all interior holes to prevent drafts from affecting temperature readings.

2.6 DDC INPUT/OUTPUT SENSORS

A. Air Static/Differential Pressure Transmitters:
   1. Variable capacitance type with ranges not exceeding 150 percent of maximum expected input. Transmitter shall have zero and span adjustments.
   2. Safe overpressure rating shall be minimum 5 times the range.
   3. Temperature compensated with thermal error of not greater than 0.04 percent of full scale in temperature range of 40 to 100 deg F.
   4. Accuracy: One percent of full scale.
   5. Manufacturers:
      a. Dwyer.
      b. Setra.
      c. Modus.
      d. Air Monitor.

B. Carbon Dioxide Sensors:
   1. Carbon dioxide sensing cell shall consist of a nondispersive infrared carbon dioxide gas cell that uses a pulsed source and has no free air optical path. Output shall be linearized 4-20 mA with the 24 VDC input. In addition, the unit shall be capable of providing SPDT switching of an external low voltage circuit at an adjustable setpoint. The unit shall be specifically designed for the wall or duct application specified. Return air aspiration boxes shall be designed by and approved by the manufacturer. Unit shall have single point setpoint and span adjustment. The unit shall have no moving parts.
   2. Power for the sensor shall be extended from a transformer or adaptor installed adjacent to the DDC control panel, and shall be run parallel to the 4-20 mA signal cable.

Minimum requirements:	
Range	0-2,000 ppm
Accuracy	3% full scale
Repeatability	1% of full scale
Max allowable drift / yr	+/- 20 ppm
Min Calibration Interval	5 years

   3. Contractor shall provide all necessary equipment and test gas for calibration and shall calibrate all CO_2 sensors in accordance with the manufacturers recommendations.
   4. Manufacturer:
      a. Honeywell.
      b. Invensys.
      c. Siemens.
      d. TelAire.
      e. Vaisala.
      f. Veris.

C. Current Switches:
   1. Split-sore donut transformer type for monitoring AC current, with digital output signal. Current switches used on motor side of variable frequency drives shall have low frequency detection capability.
   2. Current switches with digital output shall have adjustable trip settings. Field adjust current switches to trip at approximately 90% of normal motor operating amperage.
   3. Manufacturers:
      a. NK Technologies.

b. Senva.
c. Setra.
d. Veris Industries.

D. Outside Air Flow Differential Pressure Transmitters:
1. The transmitters shall be capable of receiving signals of static, velocity and reference pressures, amplifying and scaling the resulting differential pressure signal to produce a 4-20 mA output signal linear to differential pressure. The transmitters shall have manual zeroing capability.
2. The differential pressure transmitters shall not be affected by overpressurization up to 1 psig, and shall be furnished with a factory calibrated span and automatic zeroing circuit. The transmitters shall be housed in an enclosure with integral terminal box and with power and output signal conduit connection ports and separate access plate.
3. Calibrated span: shall not exceed 150 percent of maximum expected input.
4. Reference Accuracy: ± 0.50% of span.
5. Hysteresis and dead band (combined): Less than 0.2% of span.
6. Repeatability: 0.15% of span.
7. Linearity: ± 0.25% of span.
8. Include LCD Display.
9. Manufacturers:
a. Air Monitor-Velton DPT 2500 Plus.
b. Custom Electronics Systems.

E. Outside Air Temperature/Humidity Combination Transmitters:
1. Dual transmitters housed in a single hinged enclosure with integral probes configured for exterior wall mount application with PVC sun shield. Unit shall provide separate 4-20 mA signals for temperature and humidity measurement.
2. Temperature sensor shall be 1000 OHM thin film platinum resistance temperature detector with matching 4-20 mA transmitter having independent zero and span adjustments. Accuracy shall be ± 0.5 degrees F with a range of -25 degrees F to 125 degrees F.
3. Humidity sensor shall be washable thin film type with matching 4-20 mA transmitter having independent zero and span adjustments and linear output over a span of 0-100% RH. Accuracy shall be ± 2.5% RH over the range 0-95% RH at 25 degrees C.
4. Manufacturer:
a. GE Industrial, Sensing (formerly General Eastern)
b. Veris.

F. Temperature Sensors:
1. Resistance temperature detectors (RTD) with platinum, nickel or balco element. Accuracy shall be +/- 0.5 deg F over the entire range. Range shall be as indicated below, or as appropriate to the application.
2. Single point duct mounted sensors shall have 18" rigid probe and calibrated span of 20 - 120° F.
3. Averaging duct mounted sensors shall have 25' long averaging element and calibrated span of 20 - 120° F.
4. Liquid immersion sensors shall have welded stainless steel thermowell. Length of sensor and thermowell shall be selected based on the diameter of the pipe to provide accurate, reliable and homogeneous sensing of the liquid temperature. Thermowell pressure rating shall meet or exceed the system minimum pressure rating. Sensors for chilled water application shall have calibrated span of 20 - 120° F.
5. Room sensors shall have locking white cover and a minimum span of 40 - 90° F.
6. Outside air sensors shall have watertight inlet fitting and shall be shielded from direct rays of sun.

7. Manufacturers:
    a. Specified BAS product where available.
    b. TCS.
    c. Minco.
    d. ACI.
    e. MAMAC.

G. Differential Pressure Transmitters
1. Transmitters used for measuring differential pressure only:
    a. Each differential pressure transmitter shall be selected and calibrated for operations between 0 and 200% of the normal differential pressure. The calibration point shall be rounded upward to the nearest 10 inches of water column (for spans less than 200" W.C.) or to the nearest 5 psi for larger spans. Calibration date shall be included on an embossed tag attached to each transmitter.
    b. The accuracy, including linearity, hysteresis and repeatability, of the transmitter for measuring differential pressure shall be better than 2% of the span stated above throughout a 4:1 turndown.
    c. The transmitter shall not be damaged by pressures of up to 500 psig on either side of the transmitter and all wetted parts shall be essentially inert in the presence of up to a 40% concentration of ethylene or propylene glycol in water.
    d. Provide a drain valve for each side of the pressure chamber. Furnish and install mounting brackets appropriate for the installation location.
    e. Span and zero shall be individually adjustable.
    f. With LCD Display.
    g. Manufacturers:
        1) Dwyer.
        2) Setra.
        3) Veris Industries.
2. Indication Gauges for Differential Pressure Transmitters:
    a. Each transmitter shall come with an indicating gauge which reads in gpm or inches of water (whichever is the final value desired). The gauge may be either an analog differential pressure gauge piped in parallel to the transmitter or a digital display wired directly to the output of the transmitter.
    b. The analog pressure gauge shall be selected and calibrated for the same span as the transmitter it serves.
    c. The accuracy, including linearity, hysteresis and repeatability, of the gauge for measuring differential pressure shall be better than 3% of the span stated above throughout its span. Calibration data shall be included on an embossed tag attached to each gauge.
    d. The gauge shall not be damaged by pressures of up to 500 psig on either side of the gauge and all wetted parts shall be essentially inert in the presence of up to 40% concentration of ethylene glycol in water.
    e. Scale shall be a minimum of 4.5" long. Furnish and install two bleed fittings for each gauge and mounting brackets appropriate for the installation location.
3. Three Valve Manifold:
    a. Provide a three-valve manifold for each transmitter. The manifold shall not be damaged by pressures of up to 500 psig and all wetted parts shall be essentially inert in the presence of up to a 40% concentration of ethylene glycol in water.
    b. The manifold shall be designed for direct mounting on the transmitter it serves and utilize two quarter turn valves to provide zeroing, blocking and normal service modes.

H. Humidity Sensors:
   1. Elements: Thin film capacitive type or bulk polymer resistance type, accurate within ± 2% RH throughout the range of 0-99% RH at 25 deg C, with linear output. Factory calibrate for maximum accuracy at mid-range of normal operating humidity. All humidity sensors shall be resistant to chlorine and other cleaning agents.
   2. Room Sensors: With locking cover matching space temperature sensors used.
   3. Duct Sensors: With duct probe and mounting plate.
   4. Manufacturers:
      a. Specified BAS product where available.
      b. Rotronic.
      c. GE Industrial, Sensing (formerly General Eastern).
      d. Vaisala.

2.7 DDC DATA COMMUNICATIONS NETWORK

A. Data communication network shall be provided to allow data transmission between all DDC panels and between the DDC panels and the Operator Workstation.
B. The BAS/DDC system-wide communication network shall consist of a primary peer-to-peer network, and at the Contractor's option, secondary sub-networks linked to the primary network. The primary network shall support peer-to-peer communications between primary network DDC panels. The Operator Workstation shall be connected to the primary network. The secondary sub-networks shall interface with the primary network though the primary network DDC panels. At least one DDC panel connected to the primary peer-to-peer network shall be provided in each mechanical room, or as indicated on the drawings.
C. Data communications media shall be twisted pair wires.
D. The communications network shall allow shared point and control information between DDC panels without dependence on the Operator Workstation. All required repeaters, hubs, active links, gateways, etc. and associated power supplies shall be provided as required to provide shared point and control information between DDC panels.
E. Failure of any individual DDC panel shall not cause the loss of communications between peer DDC panels.
F. All data transmitted must be positively acknowledged as received or negatively acknowledged as not received. Negative acknowledgments shall cause a retransmission of the data. Network connected devices must send a "functioning" message each network cycle. Lack of a "functioning" message after successive retries shall constitute a device failure and shall be recognized as such by the network.
G. Error recovery and communication initialization routines shall be resident in each network connected device.

2.8 DDC OPERATOR WORKSTATION SOFTWARE

A. Operating System.
   1. Real time based system which shall provide true multi-tasking capability. Multi-tasking shall allow the user to perform concurrent execution of multiple real time tasks.
   2. It shall not be acceptable for background applications to be suspended while foreground applications are executed.
B. Database Manager.
   1. Database manager shall manage all data on an integrated and non-redundant basis. It shall allow additions and deletions to the data base without any detriment to the existing data. Cross linkages shall be provided such that no data

required by a software program may be deleted by the operator until that data has been deleted from its respective program.

2. Menus shall clearly guide the operator through the database editing process. Database editing shall not interfere with any other Operator Workstation function.
3. All database and/or program changes made at the Operator Workstation shall automatically be transferred from the Operator Workstation to the DDC Panels. All database and/or program modifications made at the DDC panels shall automatically be transferred to the Operator Workstation and stored on disk at the Operator Workstation.
4. Database Format:
   a. Divide points of control or monitoring by system.
   b. Identify points with unique, structured point identifier reflecting "specific area" or "specific system," and "specified point."

C. Operator Interface Software
1. General: Hierarchical linked dynamic graphical user interface for access and display of system data and for commanding and modifying equipment operation. The user interface shall utilize the mouse or keyboard to provide "heads up" operation with pull-down menus, dialogue boxes, zoom, coloration and animation to facilitate ease of operation of the system. Multiple levels of graphic penetration shall be provided with operator assignable hierarchy. Dynamic system data points shall be assignable to each penetration level. Descriptors for graphics, points, alarms, etc. shall be modified through the Operator Workstation (under password control).
2. Operator access and password protection:
   a. Operator access into the system shall require a password. A minimum of twelve (12) operators shall be able to be assigned a unique password. All sign-on/sign-off activity shall be automatically archived on the operator's station disk for subsequent display or printout as desired. The operator's initials shall be displayed on all reports and alarm acknowledgments.
   b. At least the following three levels of system access shall be assignable to each operator:
      1) Level 1: Monitoring only
      2) Level 2: Monitoring and Commanding
      3) Level 3: Monitoring/Commanding/Programming
3. Data to be displayed within a unique graphic shall be assignable regardless of physical hardware address, communication channel or point type. Graphics shall be on-line programmable and under password access control. Points shall be assignable to multiple graphics where necessary to facilitate operator understanding of system operation and where specified. Graphics shall also contain calculated or "software" points. Each physical point and each point assigned to a graphic shall be assigned an English descriptor for use in reports.
4. Data segregation shall be provided for control of specific data routed to a printer, another Operator Workstation, or other peripheral. Point classes shall be randomly selectable such as all HVAC points, HVAC points second floor, all space temperature points, command points, etc. Display and/or output of data to a printer or monitor shall occur where there is a match of peripheral segregation class assignment and the point segregations. Peripherals shall be assignable and all assignments are to be on-line programmable and under password control.
5. Operator shall be able to use the mouse to move in either direction through the graphic penetration hierarchy. In addition to being able to move one level in either direction through the hierarchy, the operator shall also be able to go directly to a specific level or access a specific point without following a fixed penetration path.

6. Points shall be displayed with dynamic data provided by the system with appropriate text descriptor, status or value, and engineering unit. Coloration shall be used to designate status and alarm states. Coloration shall be variable for each class of points, as chosen by the Owner. All point displays shall be dynamic, with update rates user adjustable on a per point basis from 20 seconds to 120 seconds.
7. For operators with the appropriate password, points shall be commandable directly from the Operator Workstation using the mouse or keyboard. Each binary output point shall be displayed with its current status (e.g., Open) and shall be operator commandable to go to the opposite position. Each analog output point shall be displayed with its actual incremental status (e.g., 20% Open, 80% Open, 100% Open, etc.) and shall be operator commandable to be move to any incremental position.
8. The operator shall be permitted to split or resize the viewing screen to show one graphic on the left half of the screen and another graphic, point report, etc., on the right half screen. This shall allow real time monitoring of one part of the system while displaying other parts of the system or data from the system.
9. An on-line "help" utility shall be provided to facilitate operator training and understanding. The "help" utility shall contain text and graphics to clarify system operation. At a minimum, help shall be available for every menu item and dialogue box.
10. Electronic messaging facility shall be provided on the Operator Workstation for any operator to enter a message to another operator. When an operator with a queued message signs onto the operator station, the display shall indicate that a message is waiting. Messages shall include the time and date the message was sent and the sender's name.
11. The operator shall be able to easily obtain a hard copy of any graphic and/or text display.
12. A legend shall display on all screens indicating the color change meaning. Example: Yellow indicates a lost communication with point or controller. Etc.

D. Alarm Handling Software
1. General: Alarm handling software shall be provided to respond to alarm conditions sensed and transmitted from the DDC panels. Alarms shall be handled on a first in/first out basis in accordance with alarm priority ranking. A minimum of 20 alarms must be capable of being stored in case of simultaneous multiple alarms. Alarm handler shall be active whether or not an operator is signed on at any given time to assure that all alarms are processed at all times.
2. Alarms shall be displayed at the Operator Workstation with the following minimum information given for each alarm: Type of alarm condition, analog value or status, point descriptor, and action-taking message. Action-taking message, for each alarm, shall indicate possible corrective action as a text string capable of being up to 280 characters in length.
3. Alarms shall be assignable to appropriate Operator Workstations, operators or printers. Only those operators having the appropriate password access level shall be allowed to acknowledge alarms.
4. An alarm summary feature shall be provided to allow the operator to display and/or print out all current alarms.
5. Each point shall be assigned to an alarm class. Each alarm class shall be uniquely assigned any of the following alarm processing attributes:
   a. Alarm priority.
   b. Audible alarm duration (none, 10 seconds, 20 seconds, continuous).
   c. Audible alarm rate (slow-medium-fast).
   d. Historically archived (yes or no).
   e. Alarm printed, with printer ID.

f. Associated coloration.

6. Alarms shall announce through the BMS to an email or phone (Owners choice) on a real time basis 24 hours a day/7 days a week.
   a. Refer to paragraph 2.4.6a and 2.4.6b for further information.

E. Time of Day Scheduler
1. Time of day schedules shall be created and modified in a graphic display window. A complete week's schedule shall be displayed on a single screen, with individual inputs for each of the seven days, and with the capability of multiple start/stop times per day. Holiday and "special day" inputs shall allow alternate schedules on these user-defined days. A calendar shall be included to allow time of day scheduling one year in advance.
2. Each schedule shall be able to control up to 60 points.
3. Override capability for individual command points shall be provided. Overrides shall be capable of being entered up to one week in advance.
4. All schedules and override requests shall be automatically transferred to the DDC panels and executed by the DDC panels.
5. An editing function shall be provided to allow one day's schedule to be copied to the next day, or to allow one system's entire schedule to be copied to another system, etc.
6. The time of day scheduler shall work closely with the optimum start/stop programs resident in the DDC panels, as well and other application programs. For example, once the desired occupancy time is defined by the time of day scheduler, the optimum start program shall calculate the time at which the HVAC system must start to attain the desired space temperature at occupancy time.

F. Reports
1. Standard Reports: Standard reports shall be provided which shall be operator selectable to appear on the Operator Workstation, any selected printer or both. A "terminate report" command shall be available to allow the operator to stop any report in the process of being printed. The following standard preformatted reports shall be provided for operator selection:
   a. Point summary reports shall be available at any penetration level (facility, building, area, system) and shall include only points at and below that level. Point summary reports shall include the current value/status and condition, and system and point descriptors for all points. Point summary reports shall be selectable for all points, only those points in alarm, fixed points, disabled points, locked out points, locked out and in alarm points, analog input or output points, digital input or output points. All reports shall be capable of being scheduled to run at a specific time and/or interval via an operator function supported by necessary data entry templates and/or interactive prompts.
   b. Trend reports shall allow the operator to randomly select logical arrays of points to be recorded at selectable time intervals. It shall be possible to assign up to six variables to each trend report. The format, headers, footers, and calculations shall be selectable by the operator. The trend report shall be stored to disk and shall be capable of being subsequently displayed and/or printed by the operator.
   c. Alarm and run time reports shall be automatically issued to assigned printers immediately upon occurrence, and shall consist of the point descriptor, the status or value of the point with engineering unit, the time and date, and an action taking alarm message.
   d. The user shall be provided with a command trace feature selectable on a per point basis allowing the archiving of all commands issued to each point. The archived trace shall include the command, the command source, the point

ID, and the time and date. Command trace reports shall be output upon operator demand.

2. Custom Reports: A custom report capability shall be provided to allow the user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only. Custom reports shall be scheduled or requested manually. Microsoft Excel shall be provided and fully integrated with the BAS database, and available to the user.

G. Graphic Generation Software
   1. An on-line graphic development facility to allow the operator to develop new graphic displays or modify existing graphic displays, and to assign and position any array of points within each graphic display.
   2. All graphic displays shall be generated on-line through the graphic generation software package at the Operator Workstation. Graphic display generation shall not require taking the Operator Workstation off-line and shall not interfere with point archiving or alarms.
   3. Graphics shall be created through use of the mouse and keyboard.
   4. Basic drawing functions shall include, as a minimum, freehand, lines, boxes, circles, arcs, ellipses. Text shall have multiple fonts and sizes. All symbols shall be capable of being moved, rotated, flipped, and scaled in all directions. Crosshairs, dimensions and grids shall be available for developing accurately scaled drawings.
   5. A standardized graphic library of HVAC and automation symbols shall be provided, and shall include fans, control valves, motors, chillers, standard ductwork diagrams, dampers, etc. In addition, the user shall have the capability to create custom symbols and store them in the graphic library.
   6. The system shall provide expansion to a minimum of 500 graphic displays.

H. Custom DDC Programming Software
   1. Text Programming Mode
      a. Full screen text editor for creating new custom programs or editing existing programs. Programs shall be for use within the DDC panels. Text editor shall provide standard word-processing functions such as adding, modifying or deleting letters, words or full lines, search and replace function, copying blocks of text, etc.
      b. The operator shall be capable of inserting comments at any point within the program code to explain the objectives of the program and to clarify the code.
      c. The operator shall be capable of archiving program segments for use in creating new custom control programs.
      d. A library of standard DDC control algorithms shall be provided as program code archived modules to aid the operator in developing new control programs. These archived modules shall contain embedded comments to allow the operator to understand the objective of the control algorithms as well as the function of each line of the program code. The following algorithms shall be provided in the library, as a minimum: Proportional (P) control, Proportional-Integral (PI) control, Proportional-Integral-Derivative (PID) control, Adaptive Control (Self Tuning), Sequence, Reversing, Ratio, Time Delay, Time of Day, Highest Select, Lowest Select, Analog Controlled Analog Output and Digitally Controlled Analog Output.

I. System Management Software
   1. Complete utilities necessary for management of the network of DDC panels and devices.
   2. Multiple dynamic graphic displays showing each DDC panel, Operator Workstation peripheral, and communication links. Clicking on any device shall start and interactive dialogue allowing the user to observer the device status and

to select device management options. Each device shall also be provided with an English descriptor of up to 60 characters. Devices in a failed or non-responsive mode shall show up distinctly in the system graphic displays.

3. Provide software to execute and observe diagnostics of any remote device connected to the communication network and the ability to deactivate and restart the device.
4. The operator shall be provided with the ability to override the use of a portable operators unit on any remote DDC panel.

J. Third-Party Software Compatibility
1. The system must be capable of running standard, off-the-shelf, MS-DOS compatible software packages concurrently with the real time system.
2. The system shall include a windowing feature to allow the operator to monitor the real time system and use third party software simultaneously.

2.9 DDC WEB BROWSER / WEB SERVER

A. All DDC functions, including point database, graphic displays, setpoints, trending, reports, programming, etc., shall be accessible and modifiable through a standard web browser. Accessibility shall be password protected and restricted, dependent on user access levels.

B. If Web Server is required, it shall support the following minimum protocols: RMI Corba, ALC Legacy, SNMP, MODBUS, Lon, and BACnet. Software for these protocols shall be installed on the server with SSL encryption incorporated and software to protect the system from unauthorized access.

C. An interface shall be provided that allows Owner to access their BAS data via the Internet or Intranet. This interface shall use Hyper-Text Mark-up Language (HTML) based pages to send and receive data from an BAS system to a web browser. Graphics support shall be provided with graphics for this site provided.

D. The software shall operate on the Microsoft Internet Explorer (4.0 or higher) and Netscape (4.0 or higher) browsers.

E. The interface shall provide four levels of user access. Uses shall range from read only access to BAS data (Level 1) to having complete access to view and modify BAS data and user accounts (Level 4).

F. The interface shall provide user account utility, complete with a user profile database that includes user ID, encrypted password, access level, and language preference. Operators with appropriate access level shall be able to add, modify, and delete users within the user profile database and be able to change users' access level.

G. The interface shall provide a means by which the user can collect items (EMS data points) into "summary" groups. This functionality shall allow authorized users to perform actions ranging from viewing summary groups, adding or deleting items from groups, and creating new summary groups.

2.10 AIRFLOW MEASURING PROBES – OUTSIDE AIRFLOW

A. Duct airflow measuring probes shall be Thermal Dispersion type.

B. Probes shall be constructed of extruded aluminum. Probes shall be provided with mounting plate, and gasket. Probe and mounting hardware shall facilitate easy removal and reinstallation of the probes.

C. The number of sensors on each probe, and the quantity of probes provided at each location, shall comply with ASHRAE standards for duct traversing. Multiple probes provided at a single location shall be interconnected external to the duct to produce an average signal.

D. For each airflow measurement location, the measured velocity pressure shall have an accuracy within ± 2% of the full scale throughout the velocity range of 0-4000 fpm.

E. Associated transmitter at each airflow measurement location shall be provided with LCD readout to indicate with airflow (in CFM) of the connected airflow measuring station.
F. Manufacturers / Model:
   1. Ebtron / Gold Series.
   2. NJK Precision Air Flow Measurement Products.

2.11 AIRFLOW MEASURING PROBES – DUCT MOUNTED

A. Duct airflow measuring probes shall contain multiple total and static pressure sensors located along the exterior surface of the probe, designed to compensate for non-axial or turbulent flow.
B. Thermal Dispersion type technology may be used in lieu of static pressure measurement.
C. Probes shall be constructed of extruded aluminum. Probes shall be provided with mounting plate, gasket, and static and total pressure fittings. Probe and mounting hardware shall facilitate easy removal and reinstallation of the probes.
D. The number of sensors on each probe, and the quantity of probes provided at each location, shall comply with ASHRAE standards for duct traversing. Multiple probes provided at a single location shall be interconnected external to the duct to product an average signal.
E. For each airflow measurement location, the measured velocity pressure shall have accuracy within ± 2% of the full scale throughout the velocity range of 300-4000 fpm.
F. Each airflow measurement location shall be provided with an air volume gauge, dial and pointer type with diaphragm element. Black letters on white background, 4” diameter, with scale calibrated to permit direct reading of the airflow (in cfm) of the connected airflow measuring station. LCD readout with associated transmitter is acceptable.
G. Manufacturers:
   1. Ebrtron.
   2. NJK Precision Air Flow Measurement products.

2.12 CONTROL AND INSTRUMENTATION TUBING

A. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.
   1. Fittings: ANSI/ASME B16.22, wrought copper.
   2. Joints: ANSI/ASTM B32, 95-5 tin antimony.
B. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.
   1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
   2. Joints: Ball Sleeve compression type.
C. Polyethylene Tubing: Black, UL 1820 flame and smoke retardant where exposed in an air plenum, virgin polyethylene, conforming to modified ASTM D1693 test. All non-metallic tubing shall be minimum 1/4" O.D.; micro-sleeve is not acceptable.
   1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
   2. Joints: Compression or barbed type.

2.13 CONTROL VALVES AND VALVE OPERATORS

A. Pressure dependent Characterized Ball Valves (2-way & 3-way):
   1. Up to 2 inches: Bronze body with screwed ends, stainless steel or chrome plated brass ball, characterizing disc, stainless steel or brass stem, and resilient reinforced Teflon seats.
   2. Manufacturers:
      a. Belimo.
B. Globe Valves (2-way & 3-way):

1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, single seated, screwed ends with backseating capability, repackable under pressure.
2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc, repackable under pressure.
3. Valve stem packing shall be tetrafluorethylene, spring loaded and self-adjusting. Packless construction is acceptable.
4. Manufacturers:
   a. Belimo.

C. Electric Operators:
1. Operators shall be electronic type to accept signals from direct digital controller or modulating thermostat for proportional control.
2. Valves shall spring return to normal position as indicated. Terminal unit tempering coil control valve operators are not required to be spring return and at a minimum fail in last position.
3. Select with sufficient shut-off power for system pressure and highest operating torque, and torque requirements of valves which may stick because of infrequent use.
4. Select to provide smooth proportioning control under operating conditions normal to the system.

D. Hydronic Systems:
1. Valve minimum pressure rating shall meet or exceed the system minimum pressure rating as noted for each system in Division 20 Section “Valves,” and in Division 23 Section “Hydronic Piping.”
2. Valve minimum temperature ratings shall be 250 deg F.
3. For globe valves: Replaceable plugs and seats of stainless steel or brass, selected for maximum lift under application conditions.
4. Two way and three way valves shall have equal percentage characteristics. Size two way valve operators to close valves against pump shut off head.
5. Pressure Drop for pressure dependent characterized ball and globe valves: As scheduled on the drawings. If not scheduled, primary HVAC equipment control valves shall be selected for a pressure drop close as possible to 11.5 feet of head (5 psi), +/- 10%. If not scheduled, terminal equipment control valves shall be selected for a pressure drop close as possible to 11.5 feet of head (5psi) with allowable minimum of 2.3 feet of head (1 psi) where flow rates are minimal and valve Cv choices are limited. TC Contractor shall use valves from listed manufacturers that meet the pressure drop requirements.

E. Solenoid Valves:
1. Solenoid valves for reheat coils, radiant ceiling panels and unit heaters shall be 24 VDC electronic type for two position operation.

2.14 DAMPERS - AUTOMATED

A. Performance: Test in accordance with AMCA 500.
B. Frames: Galvanized steel, minimum 16 gauge, minimum 2 inches in width, welded or riveted with corner reinforcement for 12 gage structural equivalence.
C. Blades: Galvanized steel, minimum 14 gauge, maximum blade size 8 inches wide, 60 inches long, attached to minimum 1/2 inch shafts. Dampers which are required to have a static pressure rating over 4 inch W.G. shall have minimum 3/4 inch solid shafts.
D. Blade Seals: Synthetic elastomeric or Neoprene, mechanically attached, field replaceable.
E. Jackshafts (where required): Minimum 1/2 inch galvanized steel.
F. Jamb Seals: Stainless steel.

G. Bearings: Oil impregnated sintered bronze or lubricant free, solid stainless steel. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.
H. Linkages: Accessible for maintenance. Linkages may be located in airstream. Linkages located in damper frame shall be external to the duct, accessible for maintenance. Linkages located in the airstream shall be zinc-plated.
I. Leakage: Less than 8 CFM per square foot based on 4 inches W.G. pressure differential.
J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4" W.G.
K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.
L. Temperature Limits: -40 to 200 deg F.
M. Manufacturers:
   1. Greenheck.
   2. Tamco.

2.15 DAMPERS, INSULATED OUTDOOR AIR / RELIEF AIR / EXHAUST AIR - AUTOMATED

A. Performance: AMCA certified for Air Performance and Air Leakage.
B. Frames: Extruded aluminum, .080-inch thickness minimum, 4 inches deep minimum, thermally broken, and insulated with polystyrene or polyurethane foam insulation.
C. Blades: Extruded aluminum, internally insulated, and thermally broken. Maximum blade size 8 inches wide, 60 inches long.
D. Shafts: Minimum 7/16 inch hexagonal or square corrosion resistant zinc plated steel.
E. Blade Seals: Extruded EPDM, silicone, or synthetic elastomeric, mechanically attached.
F. Jamb Seals: Silicone, or synthetic elastomeric, mechanically attached.
G. Bearings: Dual bearing assembly of durable synthetic polymer resulting in no metal-to-metal contact. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.
H. Linkage: Linkage shall be installed in the frame side and shall be constructed of aluminum and/or corrosion resistant zinc plated steel.
I. Leakage: Less than 3 CFM per square foot at 1 inch W.G. pressure differential at minus 40 deg F.
J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4 inches W.G.
K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.
L. Temperature Limits: Minus 40 to 155 deg F.
M. Manufacturers:
   1. Greenheck ICD-45.
   2. Tamco Series 9000 BF

2.16 DAMPER OPERATORS - ELECTRIC

A. Electric damper motor shall be 24 or 120 volt two position or modulating as required with spring return type and sized to operate the damper with sufficient reserve power for smooth operation from full close to full open and tight shut-off. Damper motor shall have "O ring" gaskets for weatherproof operation.
B. Number: Sufficient to achieve unrestricted movement throughout damper range. Provide sufficient number of operators such that one operator does not operate more than the maximum square footage of damper area as recommended in standard catalog of manufacturer.
C. Manufacturers:

1. Belimo.

2.17 DIFFERENTIAL PRESSURE SWITCHES

A. Shall provide electrical switching action upon a sensed pressure differential increase between two points. Sensitivity shall be suitable for the application. Setpoint shall be adjustable over the full range of the device. Switching action shall open or close two independent single pole double throw switches. Electrical switch rating shall be 10 amps at 120 VAC.
B. Pressure rating of switch and connecting tubing:
   1. Fan - Rated for 12 inches W.C.
   2. Pump - Meet or exceed the system pressure rating as noted in the specifications.

2.18 ELECTRICAL REQUIREMENTS FOR CONTROLS WORK

A. Electrical accessories such as relays, switches, contactors and control transformers shall meet the requirements of the Division 26 Specifications of respective project.
B. Electrical wiring and conduit shall meet the requirements of the Division 26 Specifications.
C. All control wiring in shall be run in conduit except as stated elsewhere in this specification section.
D. Conduits carrying control wiring shall be sized for a maximum fill of 40% of capacity. Minimum conduit size is ¾ inch.
E. Where raceway is required, two separate raceway systems shall be provided; one for A.C. wiring and the other for D.C. wiring.
F. Data transmission cabling and equipment grounding procedures shall meet the latest FCC guidelines for electromagnetic field generation.
G. All control wiring sizes and types shall meet or exceed the equipment manufacturer's recommendations.

2.19 INDICATING GAUGES - DUCT STATIC PRESSURE

A. 4" diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, scale as indicated on drawings or as appropriate for application, suitable for surface or flush mounting. Accuracy ± 2 % of full scale.
B. Where indicated on drawings, gauge shall incorporate high and low pressure switches. Switches shall be front adjustable over the full range of the gauge with pointers and with adjustable deadband to 1% of full scale. Separate electrical contacts shall close upon reaching the high or low pressure setpoints.
C. Manufacturer:
   1. Dwyer "Magnehelic" or "Photohelic."

2.20 LIMIT SWITCHES

A. Oil tight type with operator as required to provide required function. Limit switches used on dampers should be set at approximately 75% of full stroke.
B. Manufacturers:
   1. Allen-Bradley.
   2. General Electric.
   3. Square D.
   4. Westinghouse.
   5. Micro-switch.

2.21 LOCAL AND AUXILIARY CONTROL PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights,

pushbuttons and switches flush on cabinet panel face, or as detailed on drawings. Provide panel with locking door.

B. ANSI/NEMA 250, general purpose utility enclosures with enameled finished face panel, or as indicated on the drawings.

C. Panels shall be sized for a maximum fill of 50% capacity, and shall not be smaller than 24" X 24".

2.22 REFERENCE PROBE - DUCT STATIC PRESSURE

A. Duct static pressure probe shall be capable of static pressure measurement with bi-directional flow in a duct, plenum or air handling unit. Probe shall have minimum 4" insertion depth, shall compensate for total pressure error, and shall provide an accurate, repeatable and stable static pressure value with a maximum flow of 4000 fpm.

B. Probe shall be constructed of aluminum, with mounting flange suitable for round or flat duct surfaces. Probe shall have static pressure signal fitting.

C. Manufacturers:
   1. MAMAC # A-520.
   2. Dwyer # A-305.
   3. Tek-Air # T-SPP 7100/7200.

2.23 REFERENCE PROBE - INDOOR STATIC PRESSURE

A. Indoor pressure reference probe shall be a shielded static pressure sensor suitable for flush mounting in the ceiling, complete with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, control tubing take-off fitting, and brush finish on exposed surface. Probe shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow of 1000 fpm from a radial source.

B. Manufacturers:
   1. Air Monitor Corporation.
   2. Tek-Air.

2.24 THERMOMETERS - AIRSTREAM

A. ASTM E1, 4 inch diameter dial in stainless steel or drawn steel with enamel finish case, vapor or liquid actuated with brass or copper bulb, copper or bronze braided capillary of sufficient length and with necessary bulb supports within airstream, white with black markings and black pointer, unbreakable lens, 1 percent scale accuracy. Maximum scale divisions shall be 2 deg F. Select scale ranges such that all expected temperatures are within the range but such that the range does not extend beyond the extremes more than 25 degrees.

B. Manufacturers:
   1. Trerice.
   2. Weksler.
   3. Marsh.
   4. Honeywell.
   5. Invensys.
   6. Siemens.

C. Line Voltage Thermostats: Maximum dead band of 2 degrees F concealed temperature adjustment, and locking cover, rated for load, single or two pole as required. Provide with integral manual On/Off/Auto selector switch where indicated. Provide with locking covers when located in public areas.

D. Electric Room Thermostats (single setpoint type): Adjustable type, single setpoint, containing single bimetallic element, adjustable differential, minimum setting no greater than 1-1/2 deg F over a range of 55 deg F to 85 deg F. Provide locking

covers with key operated setpoint adjustment, exposed setpoint indicator and exposed thermometer.

E. Room Thermostat Accessories:
   1. Thermostat Covers: Manufacturers standard with finish as selected by Architect.
   2. Insulating Bases: Provide one inch insulating base for thermostats located on exterior walls.
   3. Adjusting Key: As required for device.

F. Electric Low Limit Duct Thermostat (freezestat): Snap acting, manual reset switch which trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint, fixed 5 deg F differential, range 30 deg F to 60 deg F, requiring minimum 20 feet length of bulb. Provide one thermostat for every 20 sq ft of coil surface. Switch shall be UL listed and rated for 10 amps at 120 VAC. Provide additional switch or contacts for connection to monitoring system.

G. Electric High Limit Duct Thermostat: Snap acting, manual reset switch.

H. Strap-on Aquastat: UL listed, with a suitable removable spring clip attaching aquastat to pipe and a snap-acting SPDT switch.

I. Manufacturers:
   1. Honeywell.
   2. Invensys.
   3. Siemens.

PART 3 - EXECUTION

3.1 INSTALLATION - CONTROL SYSTEMS

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of temperature sensors, thermostats and other exposed control sensors with plans and room details before installation. Locate room temperature sensors and thermostats 48 inches above floor unless noted otherwise.

C. The location of all control-related items to be mounted on the exterior of the building must be approved by the Architect prior to installation. Indicate proposed locations on the shop drawings.

D. Caulk both sides of damper frames to duct walls to prevent leakage between damper frame and duct.

E. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. Sensors used for closed loop control must be connected to the same DDC panel as the associated output signal.

F. Provide conduit and electrical wiring where required.

G. All wiring in altered and unaltered areas shall be run concealed. Use of "wiremold" or exposed conduits will be permitted only where approved by the Architect.

H. Splicing of DDC sensor cabling at junction boxes shall not be acceptable.

I. All equipment which has moving parts and is remotely started by the control system shall be provided with warning labels no less than 2 inches in height, and in bright warning color, stating that the equipment is remotely started by automatic controls. Such labels shall be posted clearly in the area of any moving parts, such as belts, fans, pumps, etc.

J. Coil and conceal excess capillary on remote element instruments.

K. Install thermometers in air duct systems on flanges.

L. Install all gauges and thermometers in locations where they are easily read from normal floor level. Provide tubing or wiring as required.

M. Locate all control components and accessories such that they are easily accessible for adjustment, service and replacement.

N. Locate, size and support sensing elements in airstreams so that they properly sense the representative condition. Controlling, transmitting and indicating elements shall

be located to sense the average condition. Safety elements shall be located to sense the extreme condition.

O. Locate and size sensing elements in liquid lines so that they are in moving liquid and not in stagnant or turbulent locations. Wells shall not obstruct the flow of the liquid being measured. Pipes one inch and smaller shall be increased at least one pipe size at the point of insertion.
P. Locate pressure sensing taps in liquid lines in straight runs of pipe with at least 10 pipe diameters of straight pipe both upstream and downstream of pressure tap. Provide a shut-off cock in sensing line at each pressure tap.
Q. Install pressure sensing elements in ducts and casings with clean, sharp taps to accurately read true static pressure, avoiding velocity influence and turbulence.
R. Locate, support and install all control components and accessories so that they will not be subject to vibration, excessive temperatures, dirt, moisture or other harmful conditions beyond their rated limitations.
S. Where insulation is penetrated due to the installation of sensing elements or tubing, reseal the openings air and vapor tight. Provide brackets for devices to be located on insulated surfaces so as to clear the finished surface of the insulation and to avoid puncturing the vapor seal.
T. Provide all necessary relays, switches, linkages, control devices, accessories and connections as required for a complete and operational control system as specified herein and shown.
U. All electric valve and damper operators shall be capable of moving from full closed to full open, or vice versa, within 60 seconds, unless specified as a different value per plan.
V. All flow monitoring display stations are to be mounted at eye level (~6’-0”) whenever possible and any alternate locations shall be approved by the college prior to installation.

3.2 TC CONTRACTOR DESIGN & INSTALLATION COORDINATION MEETINGS

A. Temperature Controls Shop Drawing Pre-submittal Meeting: TC Contractor’s option to schedule a meeting at the Engineer’s Office to review project design documentation for clarification purposes to aide in the TC Contractor development of TC/BAS shop drawings. For simple clarification items, TC Contractor may contact Engineer via telephone to discuss. For project scope questioning items, TC Contractor shall utilize the formal Request of Information (RFI) process.
B. Temperature Controls Shop Drawing Submittal Meeting: Project Design Engineer’s option to schedule a meeting at the Engineer’s Office to review the TC Contractor’s formally submitted drawings to address Engineer’s comments and concerns that indicate TC Contractor’s shop drawings vary from project design intent. This meeting can be avoided if TC Contractor’s shop drawing submittal is complete and Engineer is confident that documents are going to lead to an installation that meets project design intent.
C. Temperature Controls Installation Technician Meeting: Project Design Engineer’s option to schedule a meeting at the project site to meet and discuss project expectations with the TC Contractor’s field installation technician and/or project manager. Discussion may include
    1. Shop drawing review comments to ensure installation technician has the most up-to-date TC submittal.
    2. Graphics generation requirements including special Owner requirements and schedule for completion.
    3. Owner training agenda and scheduling.
    4. TC/BAS system acceptance procedures.

3.3 IDENTIFICATION AND MARKING

A. All sensors, relays, switches, etc. shall be marked with the same identification number as used on the as-built shop drawings. Use Brother P-touch label maker or similar with black text on clear or white super adhesive tape. If label applied in wet environment, spray label with clear enamel for waterproofing.
B. Wire shall be color coded according to functional use. Identify color coding format on record drawings.
C. Identify each wire as to ID number at each control panel, field device, and splice.
D. Thermostats shall be labeled with the air terminal unit number.
E. All control panels and auxiliary enclosures shall be supplied with engraved phenolic nameplate permanently attached identifying it as control panel number, system served, area served, fed from lighting panel number, circuit number, etc.
F. Temperature control conduit and junction box covers shall be painted green to signify that it is used for temperature controls. All junction box covers shall be painted green and the conduit shall be painted with a green mark (approximately 6 inches long) every 36” to 48”, on each side of a wall, etc.

3.4 GRAPHIC DISPLAY GENERATION

A. BAS graphics to be provided by MCC’s Master Systems Integrator to be coordinated with TC contractor per Temperature Controls Building Integration Requirements in Section 1.
B. The Master Systems Integrator developed graphics shall include the following:
    1. Overall campus layout which shows all of the buildings on the Owner's campus with 3D-display.
    2. Individual building layout or isometric for each building connected to the system.
    3. Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.
    4. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
        a. Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
        b. System name.
        c. Area served.
        d. Present value or status of all inputs, along with present setpoint.
        e. Present percent open for each damper, valve, etc. based on commanded position.
        f. Reset schedule parameters for all points, where applicable.
        g. Present occupancy mode.
        h. Present economizer mode, where applicable.
        i. Present outside air temperature.
        j. Associated space conditions and setpoints, where applicable.
        k. Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).
        l. Color coding to indicate normal and abnormal values, alarms, etc.
    5. Manual override capability for each on/off or open/closed controlled digital output (for fans, pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFD speed modulation type points, etc) shall be provided. Graphic display of output point auto or manual override status shall be provided.

6. All override selections shall have the following options: Override, Auto, Release, and Set. Note, the “Set” option will make the change a permanent part of the program and shall not be affected by a reboot of the system.
7. Sequence of operation in written (text) format for each HVAC system.
8. Overall BAS system schematic.
9. System management graphic for each network device and/or DDC panel.
10. BAS time delays will be indicated by graphics and display the time (countdown) with override capabilities.

3.5 OWNER INSTRUCTION AND TRAINING

A. Provide a minimum of sixteen hours (16) of combined on-site and classroom instruction and training to the Owner on the operation of the control systems for the initial installation.
B. Instruction and training shall be performed by a competent Contractor representative familiar with the control systems operation, maintenance and calibration.
C. Training shall take place after check, test, start-up of temperature controls system at a time mutually agreed upon by the Owner and Contractor.
D. Provide 5 sets of literature pertaining to the operation and maintenance of the DDC system components provided.
E. Training shall include: Setting up alarms, turn alarms on/off, access to the jace or controller, change control set points so they are permanent, rename objects (if required), creating trends and graphs.

3.6 CALIBRATION AND START-UP

A. After installation and connection of control components, test, adjust and re-adjust as required all control components in terms of function, design, systems balance and performance. Make systems ready for environmental equipment acceptance tests.
B. After environmental equipment has been accepted and after the systems have operated in normal service for two weeks, check the adjustment on control components and recalibrate where required. Components not in calibration shall be recalibrated to function as required or shall be replaced. Control devices, linkages, and other control components shall be calibrated and adjusted for stable and accurate operation in accordance with the design intent and to obtain optimum performance from the equipment controlled. Cause every device to automatically operate as intended to ensure its proper functionality.
C. The system shall be 100% functionally tested with MCC representative and controls contractor including software program.

3.7 ACCEPTANCE PROCEDURE

A. Upon successful completion of start-up and recalibration as indicated in this section, the Architect shall be requested in writing to inspect the satisfactory operation of the control systems.
B. Demonstrate operation of all control systems, including each individual component, to the Owner and Architect.
C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect for inspection and approval.
D. After all items on the punch list are corrected and formal approval of the control systems is provided by the Architect, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

END OF SECTION 23 0933

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SECTION 23 1123
FUEL 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes facility fuel gas piping.

1.3 DEFINITIONS

A. Gas Main: Utility's natural gas piping.

B. Gas Distribution: Piping from gas main to individual service-meter assemblies.

C. Fuel Gas Piping: Piping that conveys fuel gas from point of delivery to fuel gas utilization devices inside the building.

D. PE: Polyethylene.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: Performance requirements are scheduled on the Drawings.

2. Exception: Fuel Gas Piping Installed within Ceilings Used as Plenums: 150 psig.

1.5 SYSTEMS DESCRIPTIONS

A. Fuel gas piping system materials are scheduled on the Drawing.

1.6 SUBMITTALS

A. Product Data: For the following:
   1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   2. .

1.7 QUALITY ASSURANCE

A. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.
B. 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.
C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
D. Protect stored PE pipes and valves from direct sunlight.

1.9 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.
B. Gas System Pressure: Not more than 5.0 psig.
C. Design values of fuel gas supplied for these systems are as follows:
   1. Nominal Heating Value: 1000 Btu/cu. ft.
   2. Nominal Specific Gravity: 0.6.

1.10 COORDINATION

A. 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 not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.

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 BLACK STEEL PIPE AND FITTINGS

A. Black Steel Pipe: ASTM A 53/A 53M; Type E or S; Grade B; Schedule 40. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.

2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.3 PIPING SPECIALTIES

A. Flexible Connectors: ANSI Z21.24, copper alloy.
B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.
C. 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-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig.
D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

A. Refer to Division 20 Section “Basic Mechanical Materials and Methods.”

2.5 SPECIALTY VALVES

A. Valves, NPS 3 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
B. Valves, NPS 4: Threaded ends according to ASME B1.20.1 for pipe threads; or flanged ends according to ASME B16.5 for steel flanges.
C. Valves, NPS 6 and Larger: Flanged ends according to ASME B16.5 for steel flanges.
D. Natural Gas Valves, NPS 3 and Smaller: Use the following:
   1. Ball Valves: Bronze or brass body with AGA or CSA stamp, UL listed or FM approved for service, with chrome-plated brass ball and lever handle; 125-psig minimum pressure rating.
      a. Manufacturers:
         1) Apollo Valve; Conbraco Industries, Inc.
         2) Jomar International Ltd.
         3) Legend Valve and Fitting, Inc.
         4) NIBCO INC.
         5) Watts Water Technologies, Inc.; Watts Regulator Co.
      b. Tamperproof Feature: Include design for locking.
E. Natural Gas Valves, NPS 4: Use any of the following:
   1. Cast-Iron, Eccentric Plug Valves:
      a. Manufacturers:
         1) Homestead Valve; a division of Olson Technologies, Inc.; Keycentric Series 300.
         2) Milliken Valve Company; Mueller Water Products; Model 625.
      b. Approvals: UL approved.
      c. Body: Cast iron, complying with ASTM A 126, Class B.

d. Plug: Bronze or nickel-plated cast iron.
e. Stem Seal: Compatible with natural gas.
f. Resilient Plug Seal: Compatible with natural gas.
g. Operator: Square head or lug type with tamperproof feature where indicated.
h. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
i. Pressure Class: 125 psig.

2.6 PRESSURE REGULATORS

A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.
   1. Manufacturers:
      a. Service Pressure Regulators:
         1) Elster Gas North America; Elster American Meter.
         2) Fisher Controls International, Inc.; Division of Emerson Process Management.
         3) Itron Gas.
      b. Line Pressure Regulators:
         1) Elster Gas North America; Elster American Meter.
         2) Fisher Controls International, Inc.; Division of Emerson Process Management.
         3) Itron Gas.
   2. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
   3. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges.
   4. Service Pressure Regulators: ANSI Z21.80. Include 100-psig- minimum inlet pressure rating.
   5. Line Pressure Regulators: ANSI Z21.80/GCA 6.22 or ANSI B109.4/CGA 6.18, with inlet pressure rating as scheduled on the Drawings.
   6. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for fuel gas piping system to verify actual locations of piping connections before equipment installation.
   1. 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 PIPING SYSTEM 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. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
D. 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.
E. Concealed Locations:
    1. Above Inaccessible Ceiling Locations: Gas piping with welded joints may be installed in inaccessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above inaccessible ceilings.
    2. Above Accessible Ceiling Locations: Gas piping with welded joints may be installed in accessible ceiling spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above ceilings used as plenums.
    3. In Floor Channels: Gas piping may be installed in floor channels, subject to approval of authorities having jurisdiction. Channels must have cover and be open to space above cover for ventilation.
    4. Underground Beneath Building: Gas piping may be installed in protective conduit in accordance with Chapter “Gas Piping Installations” in the International Fuel Gas Code.
    5. In Partitions: Do not install concealed piping in solid partitions, unless installed in a chase or casing.
        a. Exception: Piping passing through partitions or walls.
    6. In Walls: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in masonry walls, subject to approval of authorities having jurisdiction.
    7. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
F. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
    1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
G. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.
H. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
I. Connect branch piping from top or side of horizontal piping.
J. Install strainer on inlet of each automatic and electrically operated valve.
K. Install pressure gage upstream and downstream from each line pressure regulator. Pressure gages are specified in Division 20 Section "Meters and Gages."
L. Locate valves for easy access.
M. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
N. Install flanges when connecting to valves, specialties, and equipment having NPS 2-1/2 and larger connections.
O. Install gas valve or plug valve and strainer upstream from each line pressure regulator or appliance pressure regulator.

P. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.
Q. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Division 20 Section "Basic Mechanical Materials and Methods."
B. Use materials suitable for fuel gas.
C. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 20 Section "Hangers and Supports."
B. 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.
C. Support vertical steel pipe at each floor and at spacing not greater than 15 feet.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.
B. Install piping adjacent to appliances to allow service and maintenance.
C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.
D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.7 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. Additional Testing: Subject welded fuel gas piping installed within ceiling spaces used as plenums to test pressure of 150 psig for a minimum of 2 hours.
D. Natural-gas piping will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.
F. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, and maintain lubricated plug valves.

END OF SECTION 23 1123

SECTION 23 2113
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.

B. Related Sections include the following:

1. Division 07 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
2. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
3. Division 20 Section “Mechanical General Requirements.”
4. Division 20 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
5. Division 20 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
6. Division 20 Section “Pipe Flexible Connectors, Expansion Fittings and Loops.”
7. Division 20 Section "Meters and Gages" for thermometers, flow meters, flow measuring devices, and pressure gages.
8. Division 20 Section "Mechanical Identification" for labeling and identifying hydronic piping.

9. Division 23 Section "General-Duty Valves for HVAC" for general-duty gate, globe, ball, butterfly, and check valves.
10. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
11. Division 23 Section "Temperature Controls" for temperature-control valves and sensors.
12. Division 23 Section “Piping Systems Flushing and Chemical Cleaning.”
13. Division 23 Section “Water Treatment for Closed-Loop Hydronic Systems.”

1.2 DEFINITIONS

A. CPVC: Chlorinated polyvinyl chloride.
B. HDPE: High density polyethylene.
C. PP: Polypropylene.
D. PVC: Polyvinyl chloride.
E. PTFE: Polytetrafluoroethylene.
F. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
G. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.3 PERFORMANCE REQUIREMENTS

A. Where not indicated on the Drawings, hydronic piping components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
   1. Glycol Cooling-Water Piping: 125 psig at 150 deg F.

1.4 SYSTEMS DESCRIPTIONS

A. Hydronic piping system materials are scheduled on the Drawings.

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. Hydronic specialties.
B. Shop Drawings: Detail, at minimum 1/4scale, 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.
C. Qualification Data: For Installer.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. 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 1.
B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

1.7 EXTRA MATERIALS

A. 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. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
C. DWV Copper Tubing: ASTM B 306, Type DWV.
D. Wrought-Copper Socket Fittings: ASME B16.22.
E. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Schedule 40 Steel Pipe: ASTM A 53/A 53M or ASTM A 106, Type E or S, Grade A or B. Include ends matching joining method.
   1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
   2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body, with ball-and-socket, metal-to-metal, bronze seating surface and female threaded ends.
   3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
   4. Cast-Iron Flanges: ASME B16.1, Class 125.
   5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125.
B. Grooved Mechanical-Joint Fittings and Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.; Gruvlok Manufacturing; Model 74 SlideLOK Ready for Installation Coupling.
      b. Tyco Fire & Building Products; Grinnell Mechanical Products; Model 740 Rapid Installation Pivot-Bolt (GRIP) Rigid Coupling.
      c. Victaulic Company; 107 QuickVic Rigid Coupling.
   2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
   3. Gaskets: Synthetic rubber gasket of central cavity pressure-responsive design suitable for temperatures from minus 30 deg F to 250 deg F. Select gasket for high vacuum services.
   4. Couplings: Ductile- or malleable-iron housing with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
      a. Rigid Type: To provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.

2.3 JOINING MATERIALS

A. Refer to Division 20 Section “Basic Mechanical Materials and Methods.”

2.4 VALVES

A. General Service Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC."

2.5 SPECIALTY VALVES

A. Balance Valves:
   1. Balance Valves NPS 6 and Larger: Lug type butterfly valves with aluminum bronze disc, AISI 300 Series stainless steel stem, resilient replaceable seat for service at not less than 250 deg F and memory stops. Refer to Division 23 Section “General-Duty Valves for HVAC” for additional requirements.

a. Provide lubricated enclosed screw or worm gear operator with handwheel for sizes 6 inches and larger.
b. Pressure rating shall meet or exceed system minimum pressure rating.

2. Flow Measuring: Use Flow Measuring Devices as specified in Division 20 Section "Meters and Gages."
3. Balance Valves for Sizes Less than NPS 6 Combination balance valve and flow measuring device as specified in this Section.

B. Combination, Balancing Valves and Flow Measuring Devices NPS 2 and Smaller:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Flow Design Inc.
b. Griswold Controls.
c. Hydronic Components, Inc. (HCi).
d. Nexus Valve.
e. PRO Hydronic Specialties, LLC.
2. Body: Brass or bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Plated 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: Lever, with memory stop to retain set position.
9. WOG Rating: Minimum 400 psig.
10. Maximum Operating Temperature: 250 deg F.

C. Combination, Balancing Valves and Flow Measuring Devices NPS 2-1/2 through NSP 4:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Flow Design Inc.
b. Griswold Controls.
c. Hydronic Components, Inc. (HCi).
d. Nexus Valve.
e. PRO Hydronic Specialties, LLC.
2. Body: Cast-iron or steel body, ball, plug, butterfly, or globe pattern with calibrated orifice or venturi.
3. Stem Seals: EPDM O-rings.
4. Disc: Glass and carbon-filled PTFE.
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. WOG Rating: Minimum 200 psig.
10. Maximum Operating Temperature: 225 deg F.

D. Contractor Option for Combination, Balancing Valves and Flow Measuring Devices NPS 2 and Smaller: Preassembled coil hook up kits may be used.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Flow Design Inc.; Complete Coil Hook-Up.
b. Griswold Controls.
c. Hydronic Components, Inc. (HCi).
d. Nexus Valve; Coil Pak.
e. PRO Hydronic Specialties, LLC.

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; Xylem Inc.
      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. Valve Seat and Stem: Noncorrosive.
   9. 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-Assist Operated Relief Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol, Inc.
      b. Anderson Greenwood & Co.; Kunkle Valve Division.
      c. Armstrong Pumps, Inc.
      d. Bell & Gossett; Xylem Inc.; Models 790 and 1170.
      e. Conbraco Industries, Inc.; Apollo Valve.
      f. Spence Engineering Company, Inc.
      g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Body: Bronze or brass.
   3. Disc: Glass and carbon-filled PTFE.
   4. Seat: EPDM.
   5. Stem Seals: EPDM O-rings.
   6. Diaphragm: EPDM.
   7. Wetted, Internal Work Parts: Brass and rubber.
   8. Valve Seat and Stem: Noncorrosive.
   9. 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. Diaphragm-Operated Relief Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol, Inc.
      b. Anderson Greenwood & Co.; Kunkle Valve Division.
      c. Armstrong Pumps, Inc.
      d. Bell & Gossett; Xylem Inc.; 3301 and 4100.
      e. Conbraco Industries, Inc.; Apollo Valve.
      f. Spence Engineering Company, Inc.
      g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Body: Cast iron.
   3. Disc: Glass and carbon-filled PTFE.
   4. Seat: EPDM.
   5. Stem Seals: EPDM O-rings.
   6. Diaphragm: EPDM.
   7. Wetted, Internal Work Parts: Brass and rubber.

8. Valve Seat and Stem: Noncorrosive.
9. 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.

2.6 CONTROL VALVES

A. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Temperature Controls."
B. Calibrated orifice balancing valves shall not be required on devices where pressure independent characterized control valves (PICCV's) are installed.

2.7 AIR CONTROL DEVICES

A. Manual Air Vents: Use ball-valve-type hose-end drain valves, refer to Division 20 Section "Valves."
B. Automatic Air Vents:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol, Inc.
      b. Armstrong Pumps, Inc.
      c. Bell & Gossett; Xylem Inc.
      d. Spirotherm, Inc.
      e. Taco, Inc.
   2. Body: Bronze or cast iron.
   3. Internal Parts: Nonferrous.
   4. Operator: Noncorrosive metal float.
   5. Inlet Connection: NPS 1/2.
   6. Discharge Connection: NPS 1/4.
   7. Maximum Operating Pressure: 150 psig.
   8. Maximum Operating Temperature: 240 deg F.
C. Bladder-Type Expansion Tanks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol, Inc.
      b. Armstrong Pumps, Inc.
      c. Bell & Gossett; Xylem Inc.
      d. Taco, Inc.
      e. Wessels Co.
   2. Tank: Welded steel, rated for 125-psig working pressure and 240 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.
   3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
   4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
D. Combination Air and Dirt Separators:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bell & Gossett; Xylem Inc.; Model CRS.
      b. Spirotherm, Inc.
   2. Body: Fabricated steel; constructed for 125-psig maximum working pressure and 250 deg F maximum operating temperature. Separator shall have body extended below pipe connections for dirt separation and include removable lower head.
   3. Air and Dirt Separation Mechanism: Internal stainless steel coalescing medium; or copper core tube with continuous wound copper medium permanently

attached followed by continuous wound copper wire permanently affixed; or PALL ring technology.
4. Venting Chamber: With integral full port, float actuated brass venting mechanism. Include valved side tap to flush floating dirt or liquids and for quick bleeding of air during system fill.
5. Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
6. Blowdown Connection: Threaded.
7. Size: Match system flow capacity.

2.8 HYDRONIC PIPING SPECIALTIES

A. Flexible connectors and expansion fittings are specified in Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."

2.9 HYDRONIC PIPING STRAINERS

A. Manufacturers:
1. Keckley.
2. Metraflex.
3. Mueller Steam Specialty.
4. Nibco, Inc.
5. Spence.
6. Sure Flow Equipment Inc.
7. Watts Water Technologies, Inc.
8. Yarway.
9. Anvil International, Inc.; Gruvlok Manufacturing (for grooved piping).
10. Tyco Fire & Building Products, Grinnell Mechanical Products (for grooved piping)
11. Victaulic Company; (for grooved piping).

B. Y-Pattern Strainers, Bronze:
1. CWP: 200 psig minimum, unless otherwise indicated.
2. SWP: 125 psig minimum, unless otherwise indicated.
3. Body: Bronze for NPS 2 and smaller.
4. End Connections: Threaded or soldered.
5. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
6. Drain:
   a. Pipe plug for sizes NPS 2 and smaller.
   b. Factory-installed, hose-end drain valve for sizes NPS 2-1/2 and larger.

C. Y-Pattern Strainers, Cast and Ductile Iron:
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-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP: 200 psig minimum, unless otherwise indicated.
5. SWP: 125 psig minimum, unless otherwise indicated.
6. Drain:
   a. Pipe plug for sizes NPS 2 and smaller.
   b. Factory-installed, hose-end drain valve for sizes NPS 2-1/2 and larger.

2.10 FILTRATION EQUIPMENT

A. Cartridge-Type Filters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cycron Corporation.
b. Eden Equipment Company; Excel Filters.
c. Filter Specialists, Inc.
d. Harmsco Industrial Filters; 801-20.
e. Hayward Industrial Products, Inc.
f. Nalco Company.
g. Parker Hannifin Corp.; Process Filtration Div.
h. PEP Filters, Inc.
i. Plymouth Products, Inc.; Pentair Water Technologies Group.
j. RainSoft Div.; Aquion Partners L. P.
k. Rosedale Products, Inc.
l. RPA Process Technologies.
m. Shelco Filters; division of Tinny Corp.
n. USFilter Corporation.

2. Description: Floor-mounting housing with filter cartridges for removing particles from water.
   a. Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through cartridge-type water filter; with base, feet, or skirt.
      1) Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
      2) Steel Housing Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
      3) Plastic Housing Pipe Connections NPS 2-1/2 and Larger: 150-psig plastic flanges.
   b. Cartridge: Replaceable; of shape to fit housing.
3. Capacities and Characteristics: Refer to Schedule on Drawings.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS INSTALLATION

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, other than drain 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 branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
P. Install valves according to Division 23 Section "General-Duty Valves for HVAC."
Q. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
R. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.
S. Install check valves at each pump discharge and elsewhere as required to control flow direction.
T. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.
U. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.
V. Install unions in piping**,** NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
W. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
X. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and where 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.
Y. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."
Z. Identify piping as specified in Division 20 Section "Mechanical Identification."

3.2 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 20 Section "Hangers and Supports." 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, 1/4 inch.
   2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.

4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
7. NPS 4 to NPS 5: Maximum span, 10 feet minimum rod size, 1/2-inch.
8. NPS 6: Maximum span, 10 feet minimum rod size, 5/8-inch.
9. NPS 8: Maximum span, 10 feet minimum rod size, 3/4-inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.3 PIPE JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 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. Glycol Systems:
1. Install automatic air vents on expansion tanks and install high capacity automatic air vents on air separators. Route vent piping to spill over glycol fill station.
2. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

E. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

F. Install combination air/dirt separator in pump suction. Install blowdown piping with ball valve; extend full size to nearest floor drain.

G. Install expansion tanks as indicated in piping diagrams. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
3. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.5 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 ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 20 Section "Meters and Gages."

3.6 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 2 hours, 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. Remove disposal fine-mesh strainers in pump suction diffusers.
   4. Set makeup pressure-reducing valves for required system pressure.
   5. 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).
   6. Set temperature controls so all coils are calling for full flow.
   7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
   8. Verify lubrication of motors and bearings.

END OF SECTION 23 2113

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SECTION 23 2123
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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

C. PEI: Pump Energy Index as defined by the Department of Energy.

D. PEI_{CL}: Pump Energy Index – Constant Load, as defined by the Department of Energy.

E. PEI_{VL}: Pump Energy Index – Variable Load, as defined by the Department of Energy.

1.3 ACTION 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.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For all pumps and accessories to include in Operation and Maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
B. Department of Energy Requirements: Pumps supplied that are regulated by the Department of Energy pump standards shall bear the acceptable PEI index.
   1. Constant load pumps supplied shall bear the acceptable PEI_{CL} index.
   2. Variable load pumps supplied with variable speed controls shall bear the acceptable $PEIv_L$ index.
   3. Submittals for approval shall clearly identify the applicable PEI index and affirm that that index meets the DOE pump standards.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 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.

1.8 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.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of pumps that fail in materials or workmanship within 60 months from date of project acceptance. Contractor shall troubleshoot issues within 24 hours of notification by the Owner. Warranty shall include all parts, labor, travel time and expenses.
B. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

PART 2 - PRODUCTS

2.1 GENERAL PUMP REQUIREMENTS

A. Pump Units: Factory assembled and tested.
B. Motors: Comply with requirements in Division 20 Section “Motors”.
C. Selection:
   1. Base non-overloading characteristics for pumps upon nameplate horsepower, at any point on performance curve.
   2. Shaft first critical speed shall not be less than 25 percent greater than operating speed.
   3. Maximum impeller diameter shall not be greater than 90 percent of “cut water” diameter for a given casing and no smaller than the smallest published diameter for casing. Do not base acceptable maximum diameter calculation on percentage of impeller diameter range for a given casing.
   4. Pump speed shall be limited to 1800 RPM except as scheduled.
   5. Select at the point of maximum efficiency for a given impeller-casing combination. Deviations shall be within 3 percent of maximum efficiency on the increasing capacity side of the maximum efficiency point and 7 percent on the decreasing capacity side of the maximum efficiency point.
   6. Select pump at a point no greater than 85 percent of end of curve flow.
   7. Maximum pump suction velocity:
      a. In-line: 12 fps.
      b. End suction: 13 fps.
      c. Double suction: 15 fps.

2.2 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.

2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS (SMALL)

A. Manufacturers:
   1. Bell & Gossett; Xylem Inc.; Series PL.
   2. Armstrong Pumps, Inc.
   3. Taco, Inc.
   4. Grundfos Pumps Corporation/PACO
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; and designed for installation with pump and motor shafts mounted horizontally.
C. Pump Construction: Bronze fitted.
   1. Casing: Radially split, cast iron, with threaded companion-flange connections.
   2. Impeller: Glass-reinforced corrosion-resistant material; keyed to shaft.
   3. Shaft: High-strength alloy steel.
   4. Seal: Mechanical, carbon/silicon carbide seal.
   5. Bearings: Permanently oil-lubricated type.
D. Motor-Single speed, with oil-lubricated bearings, unless otherwise indicated; and directly mounted to pump casing. Comply with requirements in Division 20 Section “Motors.”
E. Capacities and Characteristics: Refer to Schedule on Drawings.

2.4 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Bell & Gossett; Xylem Inc.; Series e-80.
   2. Armstrong Pumps, Inc.; Series 4360 and 4380.

3. Taco, Inc.; Series 1900.
4. Grundfos Pumps Corporation/PACO

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 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and 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: Steel with copper-alloy shaft sleeve, or stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N seal for all glycol systems and all water systems 225 deg F and below; EPT seals for water systems above 225 deg F. Include water slinger on shaft between motor and seal.

D. Motor: Single speed, with permanently or grease lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 20 Section "Motors"

E. Capacities and Characteristics: Refer to Schedule on Drawings.

2.5 FLEXIBLY COUPLED, HORIZONTAL, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
1. Bell & Gossett; Xylem Inc.; Series 60.
2. Armstrong Pumps, Inc., Series S, H, 1050, 1060.
3. Taco, Inc.; Series 1600.
4. Grundfos Pumps Corporation/PACO

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 225 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange or flanged 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: Hardened alloy steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N seal for all glycol systems and all water systems 225 deg Fand below; EPT seals for water systems above 225 deg F. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

D. Flexible Shaft Coupling: Molded rubber insert with interlocking spider or Interlocking frame with interconnecting springs 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 20 Section "Motors".

F. Capacities and Characteristics: Refer to Schedule on Drawings.

2.6 FLEXIBLY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:
1. Bell & Gossett; Xylem Inc.; Series 1510.
2. Armstrong Pumps, Inc; Series 4030
3. Taco, Inc; Series FI

4. Grundfos Pumps Corporation/PACO

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 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with 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 true back pullout. Provide receptacle bronze wear rings for all pumps with pump shaft L/D ratios greater than 6.0.
   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: Steel, with copper-alloy shaft sleeve or stainless steel.
   4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N seal for all glycol systems and all water systems 225 deg F and below; EPT seals for water systems above 225 deg F. Include water slinger on shaft between motor and seal.
   5. Pump Bearings: Permanently or grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

D. Flexible Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be center drop-out type to allow disassembly and removal without removing pump shaft or motor. Provide EPDM coupling sleeve for all motors 40 HP and below and all 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 or grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 20 Section "Motors".

H. Capacities and Characteristics: Refer to Schedule on Drawings.

2.7 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers:
   1. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
   2. Hydromatic Pump Company.

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.

2.8 AUTOMATIC CONDENSATE PUMP UNITS (PLENUM APPLICATIONS)

A. Manufacturers:
   1. Hartell Pumps Div.; Milton Roy Co.; Model A2-X-1965.

B. Description: Packaged units with corrosion-resistant pump, dual-voltage thermally protected motor, cast aluminum tank with cover, and automatic controls. Include auxiliary safety switch and factory- or field-installed check valve.

2.9 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, minimum 175-psig pressure rating, cast-iron body and end cap for NPT or flanged connections or ductile iron body and end cap for

grooved connections, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and integral locating boss for field-fabricated support.

1. Manufacturers:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett; Xylem Inc.
   c. Taco; Fabricated Products Division.
   d. Mueller Steam Specialty Company.
   e. Anvil International, Inc. (grooved only).
   f. Victaulic Co. of America (grooved only).

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 PUMP INSTALLATION

A. Comply with HI 1.4.

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. Support in-line centrifugal pumps greater than 1/2 HP independent of piping. Use continuous-thread hanger rods and hangers of sufficient size to support pump weight. Do not support pump from motor housing plate.

E. Refer to Division 20 Section “Mechanical Vibration Controls” for vibration isolation devices.

F. Refer to Division 20 Section “Hangers and Supports” for hanger and support materials.

G. Set base-mounted pumps on concrete bases. Disconnect flexible coupling before setting. Do not reconnect flexible couplings until alignment procedure is complete.
   1. Support pump baseplate on rectangular stainless steel blocks and shims, or on 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.
   3. Install pumps on inertia bases where required. Refer to Division 20 Section “Mechanical Vibration Controls” for vibration isolation devices.

H. Automatic (Cooling Coil) Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.3 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." Laser align to a tolerance of 0.0005 inches maximum.
D. After alignment is correct, tighten foundation bolts evenly but not too firmly.
E. 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.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
D. Install check valve and throttling valve on discharge side of pumps. Triple-duty valves are not allowed.
E. Install Y-type strainer or suction diffuser and shutoff valve on suction side of pumps as indicated on drawings.
F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
G. Install pressure gages on pump suction and discharge or at integral pressure-gage tappings, or install single gage with multiple-input selector valve.
H. Install check valve and gate or ball valve on each condensate pump unit discharge.
I. Install electrical connections for power, controls, and devices.
J. Ground equipment according to Division 26 Section "Grounding and Bonding."
K. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service for each pump supplied. Written report of the start-up shall be provided to the Owner and Engineer upon completion of services.
    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.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 2123

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SECTION 23 2213
STEAM AND CONDENSATE 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. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
3. Division 20 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
4. Division 20 Section "Meters and Gages" for thermometers, flow meters, and pressure and vacuum gages.
5. Division 20 Section "Mechanical Identification" for labeling and identifying steam and condensate piping.

6. Division 20 Section "Mechanical Insulation" for insulation for steam and condensate piping, and sound barrier jacketing for steam pressure reducing valves.
7. Division 23 Section "General-Duty Valves for HVAC."
8. Division 23 Section “Steam Condensate Pumps.”
9. Division 23 Section "Temperature Controls" for temperature-control valves and sensors.

1.2 DEFINITIONS

A. HP: High-pressure piping operating at more than 15 psig as required by ASME B31.1.
B. LP: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.
C. LCD: Liquid crystal display.

1.3 PERFORMANCE REQUIREMENTS

A. Where not indicated on the Drawings, components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

1.4 SYSTEMS DESCRIPTIONS

A. Steam and condensate piping system materials are scheduled on the Drawing.

1.5 SUBMITTALS

A. Product Data: For each type of the following:
   1. Pressure-reducing and safety valve.
   2. Safety relief valve connectors.
   3. Steam trap.
   4. Air vent and vacuum breaker.
B. Shop Drawings: Detail, minimum 1/4 inch equals 1 foot scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Power Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.7 COORDINATION

A. Coordinate layout and installation of steam and condensate piping and suspension system components with other construction, including light fixtures, hydronic piping, fire-suppression-system components, and partition assemblies.
B. Coordinate pipe sleeve installation for foundation wall penetrations.
C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 07 Sections.
D. Coordinate pipe fitting pressure classes with products specified in related Sections.
E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 07 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M or ASTM A 106, Type E or S, Grade A or B, and Schedule as indicated. Include ends matching joining method.
B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated.
C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated.
D. Malleable-Iron Unions: ASME B16.39; Classes 150 and 300 as indicated.
E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated; raised ground face, and bolt holes spot faced.
F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
G. Wrought-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: Weld neck.
    3. Facings: Raised face.
H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.
I. Stainless-Steel Bellows, Flexible Connectors:

2.2 JOINING MATERIALS

A. Comply with requirements specified in Division 20 Section "Basic Mechanical Materials and Methods."

2.3 VALVES

A. General Duty Valves: Comply with requirements specified in Division 23 Section "General Duty Valves for HVAC."

2.4 SPECIALTY VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, threaded ends; 150 psig SWP and 600-psig CWP ratings.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Apollo Valves; by Conbraco Industries; Series 77-140.
        b. Crane Valve Group; Crane Valves.
        c. Milwaukee Valve Company.
        d. NIBCO INC.; Model T-585-70-66.
        e. Watts Water Technologies, Inc.
    2. General: MSS SP-72, with ASTM A-351, Type CF8M, stainless-steel body; ASTM A-351, Type CF8M vented stainless-steel ball; and ASTM A-276, Type 316 stainless-steel stem; and having flanged ends and blowout-proof stem.
    3. Class 150, Full-Port, Ferrous-Alloy Ball Valves: Split-body construction, carbon-filled TFE seats; 285 psig CWP rating.
        a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
            1) Apollo Valves; by Conbraco Industries.
            2) Metso Automation; Jamesbury Valves.
            3) Milwaukee Valve Company.

4) NIBCO INC.; Model F-515-CS-F-66.

B. High-Performance Butterfly Valves: MSS SP-68.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries.
      b. Bray International, Inc.
      c. DeZurik.
      d. Forum Energy Technologies; ABZ Valve.
      e. Hammond Valve.
      f. Metso Automation; Jamesbury Valves.
      g. Milwaukee Valve Company.
      h. NIBCO INC.
      i. Pentair Valves & Controls; Keystone.
   2. ANSI Class VI Seat Leakage Classification.
   3. Disc and Seat:
      a. Disc: Double offset design constructed of Type 316 stainless steel.
      b. Shaft: Split or straight-through type, constructed of Type 316 or 17-4 PH stainless steel.
      c. Seats: PTFE, secured in place by means of a retaining ring, suitable for bi-directional dead-end service at full ANSI rating, and replaceable without removing disc or shaft.
   4. Stem Packing Gland: Adjustable with or without an actuator mounted.
   5. Include upper and lower shaft seals.
   6. Operators:
      a. Valves through NPS 4: 10-position lever handle.
      b. Valve NPS 6 and larger: Gear operators.
      c. Valves smaller than NPS 6 may be designated with gear operators if required by pressure and application.
   7. Lug-Style (Single-Flange) Class 150 and 300, High-Performance Butterfly Valves.

C. Trap Test Valve: Globe valve with bronze body, bronze trim, union bonnet, rising stem, handwheel, inside screw, renewable composition disc, threaded ends, suitable for steam service, minimum pressure rating shall meet or exceed minimum steam system pressure rating. Refer to Division 23 Section “General-Duty Valves for HVAC” for further requirements.

D. Class 300, Cast Carbon Steel Globe Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Powell, Wm. Co.
      b. Velan Valve Corporation, USA.
      c. Vogt Valve; Flowserve Corporation.
   2. Description:
      a. Standard: BS1873.
      b. Service Temperature Rating: 850 deg F.
      c. Body Material: Precision machined WCB cast carbon steel with bolted bonnet.
      d. Ends: Flanged.
      e. Trim: 13Cr stem, 13Cr faced disc, and CoCr alloy faced seats.
      f. Gasket: Spiral wound stainless steel/graphite.
      g. Packing Ring: Graphite.

2.5 SAFETY VALVES

A. Bronze or Brass Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Conbraco Industries.
    b. Leslie Controls, Inc.
    c. Spence Engineering Company, Inc.
    d. Kunkle Valve; a Tyco International LTD. Company
    e. Spirax Sarco, Inc.
2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Conbraco Industries.
    b. Leslie Controls, Inc.
    c. Spence Engineering Company, Inc.
    d. Kunkle Valve; a Tyco International LTD. Company
    e. Spirax Sarco, Inc.
2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

C. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.

2.6 SAFETY RELIEF VALVE VENT CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMERICAN BOA INC.; SRV Vent Connectors.
2. Hyspan Precision Products, Inc.; Series 3500SRV Safety Relief Valve Connectors.
3. Senior Flexonics, Inc.

B. Connector consists of:
1. External Housing: ASME A53 Grade B, standard weight pipe.
2. Bellows: Laminated or multi-ply, externally pressurized, and constructed of ASTM A240 Type 321 stainless steel.
3. Internal Liner: Full bore, and constructed of A53 Grade B standard weight pipe.
4. Drain Port and Plug: 3000 lb. forged steel welded outlet fitting.
5. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
6. Design Temperature Rating: 500 deg F.
7. End Connections: Weld.

2.7 PRESSURE-REDUCING VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong International, Inc.

2. Hoffman Specialty; Xylem Inc.
3. Spence Engineering Company, Inc.
4. Spirax Sarco, Inc.
5. Watson-McDaniel.

A. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated. Refer to Schedule on Drawings.
B. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.
   1. Body: Cast iron.
   2. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.
   3. Trim: Hardened stainless steel.
   4. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
   5. Gaskets: Non-asbestos materials.
C. Accessories: Shall be by pressure reducing valve manufacturer.
   1. Acoustic Plates: Designed for installation between ANSI 125/150 or 250/300 Class flanges and to reorient normal exit turbulence of the steam flow.
      a. Maximum Operating Pressure: 250 psig.
      b. Maximum Operating Temperature: 650 deg F.

2.8 STRAINERS

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 strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
   3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
   4. Tapped blowoff plug.
   5. CWP Rating: 250-psig working steam pressure.

2.9 BLOWDOWN SEPARATOR/CONDENSATE COOLER

A. Manufacturers:
   1. Cemline.
   2. Cleaver Brooks.
   3. Johnson.
   4. Lattner.
B. Separator tank shall be ASME code constructed and stamped for 150-psig working pressure, with tangential inlet(s), vent, and drain connections as indicated and sized on the flow diagram. Provide tank mounted on angle lens with base plates.
C. Automatic aftercooler shall consist of globe shut-off valve, check valve, strainer, automatic temperature regulating valve with sensing element, and thermometer.

2.10 STEAM TRAPS

A. Float and Thermostatic Traps:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong International, Inc.
      b. Hoffman Specialty; Xylem Inc.
      c. Spirax Sarco, Inc.
      d. Watson-McDaniel.
   2. Body and Bolted Cap: ASTM A 126, cast iron.
   3. End Connections: Threaded.

4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Maximum Operating Pressure: 125 psig.

B. Inverted Bucket Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Hoffman Specialty; Xylem Inc.
   c. Spirax Sarco, Inc.
   d. Watson-McDaniel.
2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Air Vent: Stainless-steel thermostatic vent.
8. Pressure Rating: 250 psig.

C. Thermostatic Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Hoffman Specialty; Xylem Inc.
   c. Spirax Sarco, Inc.
   d. Watson-McDaniel.
2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
3. Trap Type: Balanced-pressure.
4. Bellows: Stainless steel or monel.
5. Head and Seat: Replaceable, hardened stainless steel.
6. Pressure Class: 125.

D. Thermodynamic Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Hoffman Specialty; Xylem Inc.
   c. Spirax Sarco, Inc.
   d. Watson-McDaniel.
2. Body: Stainless steel with screw-in cap.
3. End Connections: Threaded.
4. Disc and Seat: Stainless steel.
5. Maximum Operating Pressure: 600 psig.

2.11 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Hoffman Specialty; Xylem Inc.
   c. Spirax Sarco, Inc.
   d. Trane Company.
   e. Watson-McDaniel.

2. Body: Cast iron, bronze or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 125 psig.
7. Maximum Temperature Rating: 350 deg F.

B. Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Check-All Valve Mfg. Co.
   b. Hoffman Specialty; Xylem Inc.
   c. Johnson Corporation (The).
   d. Spirax Sarco, Inc.
   e. Watson-McDaniel.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-ring Seal: EPR.
6. Pressure Rating: 125 psig.
7. Maximum Temperature Rating: 350 deg F.

PART 3 - EXECUTION

3.1 PIPING SYSTEM INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were 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 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 free of sags and bends.
G. Install fittings for changes in direction and branch connections.
H. Install piping to allow application of insulation.
I. Select system components with pressure rating equal to or greater than system operating pressure.
J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
K. Install drains, consisting of a tee fitting, NPS 3/4 full port-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.
L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.
M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.
N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Division 20 Section "Valves."
Q. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
R. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
S. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
T. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
U. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
V. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."
W. Identify piping as specified in Division 20 Section "Mechanical Identification."
X. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
    1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.
    2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

3.2 STEAM-TRAP APPLICATION

A. Use float and thermostatic traps to drain condensate from equipment served by modulating steam control valves.
B. Use inverted bucket traps to drain condensate from steam mains.
C. Size steam traps to handle minimum of two times maximum condensate load of apparatus served (at operating pressure differential) unless apparatus manufacturer recommends greater capacity. Size end of main steam drips traps to handle a minimum of three times maximum condensate load at operating pressure differential.
D. Traps used on steam mains and branches shall be minimum 3/4 inch size.

3.3 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.
B. Install steam traps with unions or flanged connections at both ends.
C. Install globe style trap test valve with hose connection and cap at all steam traps. Utilize top test plug for inverted bucket traps.
D. Provide minimum 12 inch long drip leg of same pipe sizes as apparatus return connection between apparatus and steam trap.
E. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.
F. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.4 PRESSURE-REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.
C. Install gate valves on both sides of pressure-reducing valves.
D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.
E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 20 Section "Meters and Gages."
F. Install strainers upstream for pressure-reducing valve.
G. Install accessories downstream of pressure reducing valves in accordance with manufacturer's instructions.
H. Install safety valve downstream from pressure-reducing valve station.

3.5 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.9, "Building Services Piping."
B. Pipe safety-valve discharge without valves to atmosphere outside the building.
C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
D. Install safety relief valve connector where indicated on the Drawings.
E. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.6 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 20 Section "Hangers and Supports." Comply with requirements below for maximum spacing.
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.
C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
    1. NPS 3/4: Maximum span, 9 feet; minimum rod size, 1/4 inch.
    2. NPS 1: Maximum span, 9 feet; minimum rod size, 1/4 inch.
    3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
    4. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
    5. NPS 2-1/2: Maximum span, 14 feet; minimum rod size, 3/8 inch.
    6. NPS 3: Maximum span, 15 feet; minimum rod size, 3/8 inch.
    7. NPS 4: Maximum span, 17 feet; minimum rod size, 1/2 inch.
    8. NPS 6: Maximum span, 21 feet; minimum rod size, 1/2 inch.
    9. NPS 8: Maximum span, 24 feet; minimum rod size, 5/8 inch.
D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.7 PIPE JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.8 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.
B. Install traps and 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 vacuum breakers downstream from control valve, close to coil inlet connection.
E. Install a drip leg at coil outlet.

3.9 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," 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 system with clean water. Clean strainers.
   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.
B. Perform the following tests on steam and condensate 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. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the 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.
   3. 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.
C. Prepare written report of testing.

END OF SECTION 23 2213

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SECTION 23 2223
STEAM CONDENSATE 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.
B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include receiver capacity and material.
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 operation and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain steam condensate pumps through one source from a single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
C. ASME Compliance: Fabricate and label steam condensate pumps to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.4 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 steam condensate 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.

1.5 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 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 ELECTRIC-DRIVEN STEAM CONDENSATE PUMPS

A. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pump(s), controls, and accessories suitable for operation with steam condensate.
B. Configuration: Duplex floor-mounted pumps with receiver and float switches; rated to pump minimum 210 deg F steam condensate.
   1. Manufacturers:
      a. Domestic Pump; Xylem Inc.; Series CB and CS.
      b. Aurora Pump; Division of Pentair Pump Group.
      c. Roth Pump Company.
      d. Skidmore Div.; Vent-Rite Valve Corp.
      e. Spirax-Sarco, Inc.
   2. Receiver: Floor-mounted, close-grained cast iron; externally adjustable float switches; with water-level gage, steam condensate thermometer, discharge-pressure gage for each pump, bronze isolation valves between receiver and pumps, flanges for pump mounting, and lifting eyebolts.
   3. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.
   4. Pumps: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on receiver flanges**;** rated to operate with a minimum of 2 feet of NPSH.
   5. Control Panel: NEMA 250, Type 2 enclosure with hinged door and grounding lug, mounted on pump; factory wired for single external electrical connection. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch. Minimum SCCR according to UL 508 shall be as indicated on the Drawings. Include the following components within cabinet:
      a. Combination magnetic starters (each having 3 overload relays) with fused disconnect switch and cover interlocks.
      b. Mechanical or electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
         1) Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
            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 KS 1, heavy-duty, nonfusible switch.
c) UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

c. Manual lead-lag control to override electrical pump alternator to manually select the lead pump.
d. Momentary contact "TEST" push button on cover for each pump.
e. Numbered terminal strip.
f. Disconnect switch.
g. Fused transformer for control circuit.

2.3 MOTORS

A. Comply with requirements in Division 20 Section "Motors."

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 rough installation of steam condensate piping.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install pumps according to Hydraulic Institute HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
C. Support pumps and piping separately so piping is not supported by pumps.
D. Install pumps on concrete bases. Anchor pumps to bases using inserts or anchor bolts.
E. Install thermometers and pressure gages on pump discharge piping.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20, 22, and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
C. Install steam supply for pressure-powered pumps and pumping traps as required by Division 23 Section "Steam and Condensate Piping."
D. Install check valve, isolation valve, and globe valve at pump discharge connections for each electric-driven pump.
E. Pipe drain to nearest floor drain for overflow and drain piping connections. Overflow shall have a water seal to prevent flash steam from venting through drain piping.
F. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.
G. Ground equipment according to Division 26 Section "Grounding and Bonding."
H. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 STARTUP SERVICE

A. Verify that steam condensate pumps are installed and connected according to the Contract Documents.
B. Complete installation and startup checks according to manufacturer's written instructions.
C. Clean strainers.
D. Set steam condensate pump controls for automatic start, stop, and alarm operation.

E. Perform the following preventive maintenance operations and checks before starting:
   1. Set float switches to operate at proper levels.
   2. Set throttling valves on pump discharge for specified flow.
   3. Check motors for proper rotation.
   4. Test pump controls and demonstrate compliance with requirements.
   5. Replace damaged or malfunctioning pump controls and equipment.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain steam condensate pumps.

END OF SECTION 23 2223

SECTION 23 2510
PIPING SYSTEMS FLUSHING AND CHEMICAL CLEANING

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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 22 Section “Domestic Water Piping,” for disinfection of potable water piping.
   4. Division 23 Section "Hydronic Piping.”
   5. Division 23 Section “HVAC Water Treatment.”

1.2 SUMMARY

A. This Section includes chemical cleaning for the following piping systems:
   1. Heating hot water.
   2. Chilled Water.

1.3 DEFINITIONS

A. Cleaning: Recirculating water containing chemical cleaning and passivation compounds.

B. Flushing: Using approved water on a once through basis.

1.4 PERFORMANCE REQUIREMENTS

A. Furnish the services of a firm specializing in piping system chemical cleaning and water treatment work.
   1. For chemical cleaning: This firm shall select the required type and quantity, based on system volume, of cleaning compound, and method of application.

1.5 ACTION SUBMITTALS

A. Product Data:
   1. Proposed cleaning chemicals and quantities.
   2. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

1.6 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Reduced scale plans indicating locations of velocity measurements.
B. Other Informational Submittals:
   1. Proposed, step-by-step, chemical cleaning procedure.
   2. Circulation pump suction and discharge pressure at start and completion of chemical cleaning operations.

1.7 QUALITY ASSURANCE

A. Service Provider Qualifications: An experienced piping systems cleaning service provider capable of applying cleaning compounds as specified in this Section.
B. Conduct safety meetings with Owner's Representative and personnel involved in the cleaning process.
C. Assume responsibility for damage, necessary subsequent cleaning, flushing, and inspection of Work under the Contract which results from improper flushing and cleaning operations including failure to flush all dead-ends.

1.8 COORDINATION

A. Schedule flushing and chemical cleaning activities immediately after piping system pressure testing and immediately prior to piping system chemical treatment work to minimize internal oxidization or flash corrosion of piping systems.
B. Coordinate chemical cleaning work with other work to avoid accidental chemical discharge, spillage, or spray out, and electrolytically originated system damage resulting from concurrent chemical cleaning and arc welding.
C. Coordinate with work performed under other Sections to provide in-place temporary strainers, spool pieces, flushing hose connections, cross-over piping, and isolation and drain valves.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. System Cleaning Chemicals: Subject to compliance with requirements, provide products by one of the following:
   1. GE Power & Water; Water & Process Technologies.
   2. Nalco, an Ecolab Company.
   3. Mitco Custom Water Treatment.
   4. PVS-Nolwood Chemicals, Inc.; PVS CHILL CLP Cleaner.
   5. H-O-H Chemicals, Inc.
   6. Enerco Corporation.

2.2 MATERIALS

A. Cleaning chemicals shall be as recommended by manufacturer and compatible with piping system components and connected equipment.
B. Cleaning and passivation chemical shall consist of an inorganic phosphate, yellow metal corrosion inhibitor (Tolytriazole), dispersant, and oil emulsifier.
C. Provide additional temporary and permanent piping, equipment, and materials required for chemical cleaning work.
D. Use potable water for flushing and cleaning operations, unless directed otherwise by the Architect.

PART 3 - EXECUTION

3.1 ACCEPTABLE SERVICE PROVIDER

A. Subject to compliance with requirements, provide chemical cleaning service by one of the following:
   1. GE Power & Water; Water & Process Technologies.
   2. Eldon Water (Patrick Racine, Christa Blades, or Pierre Beausoleil, 888-712-4000).
   3. Enerco Corporation (Doug White 517-627-8444 or 800-292-5908).
   4. Mitco Custom Water Treatment (Gordon Chapin, 800-516-2175).
   5. Nalco, an Ecolab Company (Brian Irwin or Tony Mackovski, 248-344-7564).
   6. H-O-H Chemicals, Inc./H.V. Burton Co.

3.2 PREPARATION

A. Prior to flushing and cleaning activities, drain the system of all water used for hydrostatic testing.
B. Temporarily connect dead-end supply and return piping as necessary to result in recirculating system in which no lines are left static for purposes of flushing and cleaning. Refer to System Piping Diagrams on the Drawings for suggested locations of temporary connections for flushing and cleaning purposes.
C. Select three locations for monitoring flow rates.

3.3 INITIAL FLUSHING

A. Remove loose dirt, mill scale, metal chips, weld beads, rust and other deleterious substances without damage to system components.
B. Bypass factory cleaned equipment, unless acceptable means of protection are provided and subsequent inspection of water boxes and other "hide-out" areas takes place.
C. Isolate or protect clean system components including pumps and pressure vessels and remove components which may be damaged.
D. Open valves, drains, vents and strainers at all system levels.
E. Remove plugs, caps, spool pieces and components to facilitate early discharge from system.
F. Sectionalize system if possible to obtain debris carrying velocity of 6 FPS.
G. Connect dead-end supply and return headers as necessary or provide terminal drains in end caps.
H. Install temporary strainers where necessary to protect down-stream equipment.
I. Supply and remove flushing water and drainage by fire hoses, garden hoses, temporary and permanent piping and Contractor's booster pumps.
J. Flush for not less than one hour.
K. Inspect system including basins to determine if debris accumulation requires dewatering and cleaning prior to next phase work.

3.4 FLUSHING AND CHEMICAL CLEANING PROCEDURES

A. Remove without chemical or mechanical damage to system components adherent dirt (organic soil), oil and grease (hydrocarbons), welding and soldering flux, mill varnish, pipe compounds, rust (iron oxide), and other deleterious substances not removed by initial flushing. Removal of tightly adherent mill scale is not required.
B. Fill system with fresh water and add manufacturer’s recommended volume of system cleaner to remove grease and petroleum products from piping. Circulate solution for 24 hours at a minimum velocity of 6 fps.
   1. Utilize defoamers to preclude damage to existing work and adjacent electrical equipment.

2. Utilize heat to maximize effectiveness of compounds or use live steam injection where practical and safe. Do not raise cleaning water temperature in excess of controlled limits.

C. Monitor flow rates and clean strainers as required to maintain minimum specified velocity during the entire circulation and chemical cleaning period.
D. Cleaning of new piping systems shall be completed prior to connection of systems to existing services.
E. Install temporary strainer screens between pipe flange faces where necessary to protect primary system from branch connections during chemical cleaning procedures.
F. Following chemical cleaning:
   1. Remove, clean, and reinstall strainer baskets.
   2. Blow down and clean low points, dirt legs, and traps.
G. Drain systems:
   1. Check with local authorities concerning discharge requirements and submit copies of letters or reports.
   2. If acceptable, drain system to sanitary drainage system.
   3. Do not under any circumstances drain to storm drainage system or open drainage ditch.
   4. If discharge requirements do not allow discharge to sanitary sewer, secure the services of a licensed disposal Contractor.
   5. Do not allow the hydronic system to enter a vacuum condition.
   6. Disposal Contractors:
      a. Dynecol.
      b. SQS Environmental.
H. Perform final flush to remove any remaining debris and chemical from the system:
   1. Flush dead ends and isolated pre-cleaned equipment.
   2. Operate valves to dislodge debris in valve body.
   3. Flush for not less than 1 hour.

3.5 PLACING INTO OPERATION

A. Clean strainers.
B. Disassemble, inspect, clean, repair, replace and reassemble any critical component or questionable item. Bellows style, and hose and braid flexible connectors left in place shall be removed and cleaned. Upon completion of flushing the system, remove construction strainers in circulation, pumps (when provided). and turn strainers over to the Owner.
C. Preliminarily adjust control valves.
D. Install clean primary filter elements, if necessary, as determined by both pressure differential across filter and visual inspection of filter elements.
E. Close-up and fill system as soon as possible to minimize corrosion of untreated surfaces.
F. Vent air from system and adjust fill valve.
G. Immediately after completion of flushing and chemical cleaning, fill systems with potable water and make ready for chemical treatment as specified in Division 23 Section “HVAC Water Treatment.”

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Withdraw, inspect, and test samples of water from each system after flushing and chemical cleaning is completed, to ensure system is free of contaminants.
   2. If loose debris or contaminants are still present, repeat final flushing procedures until test samples and strainers remain free of debris and contaminants.

END OF SECTION 23 2510

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SECTION 23 2513
WATER TREATMENT FOR CLOSED-LOOP HYDRONIC 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. Related Sections include the following:
   1. Division 20 Section "Mechanical General Requirements."
   2. Division 20 Section "Basic Mechanical Materials and Methods."
   3. Division 23 Section "Piping Systems Flushing and Chemical Cleaning."

1.2 DEFINITIONS

A. CPVC: Chlorinated Polyvinyl Chloride.

B. EEPROM: Electrically erasable, programmable read-only memory.

C. EPDM: Ethylene-propylene-diene monomer.

D. 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.

E. RO: Reverse osmosis.

F. TDS: Total dissolved solids.

G. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

H. PTFE: Polytetrafluoroethylene.

I. UV: Ultraviolet.

1.3 PERFORMANCE REQUIREMENTS

A. Furnish the services of a firm specializing in hydronic piping system water treatment work.
   1. This firm shall furnish and administer glycol for systems using glycol/water mix.

B. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
C. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
D. Base chemical quantities on estimated system size.
E. Closed hydronic systems, including hot-water heating with non-aluminum boilers, shall have the following water qualities:
    1. pH: Maintain a value within 9.0 to 10.5.
    2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
    3. Boron: Maintain a value within 100 to 200 ppm.
    4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
    5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
    6. TDS: Maintain a maximum value of 5000 mmhos.
    7. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
    8. Microbiological Limits:
        a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
        b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
        c. Ammonia: Maintain a maximum value of 20 ppm.
        d. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
        e. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
        f. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
    1. Bypass feeders.
    2. Inhibitor injection timers.
    3. pH controllers.
    4. Chemical solution tanks.
    5. Injection pumps.
    6. UV-irradiation units.
    7. Chemical test equipment.
    8. Chemical material safety data sheets.
B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
    1. Wiring Diagrams: Power and control wiring.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in operation and maintenance manuals.
    1. Submit under provisions of Division 20 Section “Mechanical General Requirements” and as supplemented in this Section.
    2. Submit following operation and maintenance data as minimum for purified water system.
        a. Furnish complete instruction manuals for installation, operation, maintenance, and lubrication requirements for each component of mechanical and electrical equipment or system.
        b. Each instruction manual shall include, but not be limited to, the following:
            1) Diagrams and illustrations.
            2) Detailed description of the function of each principal component of the system.

3) Performance and nameplate data.
4) Installation instructions.
5) Procedures for starting.
6) Proper adjustment.
7) Test procedures and recording of operation data.
8) Procedures for operating.
9) Shutdown and restart instructions.
10) Emergency operating instructions and trouble-shooting guide.
11) Safety precautions.
12) Maintenance and overhaul instructions which shall include detailed assembly drawings with part numbers, recommended spare parts list, instructions for ordering spare parts (including suppliers names), and complete preventive maintenance instructions required to ensure satisfactory performance and longevity of the equipment.
13) Lubrication instructions, which shall list points to be greased or oiled, shall recommend type, grade, and temperature range of lubricants, and shall recommend frequency of lubrication.
14) List of electrical relay settings and control and alarm contact settings.
15) Electrical interconnection wiring diagram for equipment furnished, including all control.

c. Manual shall be complete in all respects for all equipment, controls, accessories, and associated appurtenances.
d. Each O&M Manual shall be transmitted to the Owner's representative and Architect prior to installation of the equipment and all equipment shall be serviced by the manufacturer in accordance with the manufacturer's recommendations prior to operation. A service record shall be maintained on each item of equipment and shall be delivered to the Owner's representative and Architect prior to final acceptance of the project.

E. Other Informational Submittals:
1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. An analytical review of make-up water characteristics for each treated system operating conditions, including such items as Langlier/Ryzner Indexes. Based on this review, provide a definitive description of treatment system developed to achieve specified objectives and include generic terms to describe product formulation content and function. Detailed proprietary formulation data is not required. However, manufacturer's standard published literature is not usually acceptable.
3. A step-by-step procedure to be followed by the Contractor during flushing, purging, disinfecting, draining, disposal, pretreatment and treatment operations. The intent of the step-by-step procedure is two-fold.
a. To assure that all essential permanent provisions to accomplish the above work are included during the course of construction.
b. To allow the Owner to accomplish the source procedures as subsequent maintenance operations.

F. Provide OSHA equivalent materials form for hazardous substances.

1.5 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Conform to applicable codes for addition of non-potable chemicals to building mechanical systems, and for delivery to public sewage systems.

1.6 OWNER'S INSTRUCTIONS

A. Provide a coordinated water treatment training program oriented to the needs common to operating personnel and maintenance personnel and to the needs of maintenance personnel only, sufficiently prior to acceptance of the work, upon mutually satisfactory arrangement with the Architect.
B. Provide a total of not less than eight "field" hours encompassing mechanical, electrical, chemical, pollution and safety aspects, sufficient for personnel to operate and maintain systems and consistently achieve specified objectives, with subsequently scheduled guidance by the water treatment laboratory.
C. Water treatment laboratory chemical engineer, complemented by instrument engineer, supplemented by Contractor's staff, shall comprise the training staff.
D. Training materials shall include "survey," limits control program, shop drawings, operating and maintenance manuals, safe handling of chemicals, chemical testing, use of log sheets and demonstrations of installed and functioning systems.
E. On completion of the installation of the entire purified water system, conduct a thorough check and test of all components in the system. During this period, instruct the Owner's personnel in the theory, operation, and maintenance of the system. When this work is finished, start up the system and operate it for as long as necessary to complete two consecutive days of operation at the specified performance levels. During this period, continue to instruct the Owner's personnel.

1.7 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for heating, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
   1. Provide piping/plumbing recommendation to optimize chemical program results.
   2. Initial water analysis and HVAC water-treatment recommendations.
   3. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
   4. Quarterly field service and consultation.
   5. Customer report charts and log sheets.
   6. Laboratory technical analysis.
   7. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
B. Glycol manufacturer shall provide testing services every six months of samples submitted by the Owner. Fluid shall be tested at no charge for: glycol percent, pH, reserve alkalinity, dissolved metals, magnesium, calcium, chlorides, acidity, and inhibitor components. Testing service shall be for the life of the fluid.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers/Suppliers: Unless otherwise specified, and subject to compliance with requirements, provide products by one of the following:
   1. Ashland Specialty Chemical Company; Drew Industrial Div.
   2. Eldon Water. Patrick Racine, Christa Blades, or Pierre Beausoleil, 888-712-4000).
   3. Enerco Corporation. Doug White 517-627-8444 or 800-292-5908).
   4. GE Power & Water; Water & Process Technologies.

5. Mitco Custom Water Treatment (Gordon Chapin, 800-516-2175).
6. Nalco, an Ecolab Company.
7. H-O-H Chemicals, Inc. (H.V. Burton Co., 734-261-4220)

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
   1. Capacity: 2 gal.
   2. Minimum Working Pressure: 175 psig.

2.3 CHEMICAL FEED PIPE AND FITTINGS

A. CPVC Piping:
   1. CPVC Schedule 80 Pipe: ASTM F 441/ F 441M.
   2. CPVC Schedule 80 Fittings: ASTM F 439, socket type or ASTM F 437, threaded type.
   3. Isolation Valves: Three-piece true union style ball valve constructed of CPVC with TFE seats, and FPM or EPDM o-ring seals.

B. Stainless-Steel Pipes and Fittings:
   1. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
   2. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.
   3. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.
   4. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig SWP and 600-psig CWP rating.

2.4 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
B. Install water testing equipment on wall near water chemical application equipment.
C. Install meters and equipment requiring service at a maximum 60 inches above finished floor.
D. Install interconnecting control wiring for chemical treatment controls and sensors.
E. Mount sensors and injectors in piping circuits.
F. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, and equipped with the following:

1. Install bypass feeder in a bypass circuit on main header having pressure differential greater than or equal to 20 psig, unless otherwise indicated on Drawings.
2. Install water meter in makeup water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.

G. Install glycol feed system in accordance with manufacturers instructions.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.
C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 20 Section "Basic Mechanical Materials and Methods."
D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 20 Section "Valves."
E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.
F. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.
G. Ground equipment according to Division 26 Section "Grounding and Bonding."
H. Connect wiring according to Division 26 Section "Conductors and Cables."

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. Report results in writing.
B. 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.
C. Tests and Inspections:
    1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
    2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
    3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
    4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
    5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
    6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
    7. 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 test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
    8. Repair leaks and defects with new materials and retest piping until no leaks exist.

D. Equipment will be considered defective if it does not pass tests and inspections.
E. Remove and replace malfunctioning units and retest as specified above.
F. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample boiler water at eight -week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.
G. At six -week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.
H. Comply with ASTM D 3370 and with the following standards:
    1. Silica: ASTM D 859.
    2. Steam System: ASTM D 1066.
    3. Acidity and Alkalinity: ASTM D 1067.
    4. Iron: ASTM D 1068.
    5. Water Hardness: ASTM D 1126.

3.5 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.

END OF SECTION 23 2513

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SECTION 23 3113
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.

B. Related Sections include the following:
   1. Division 20 Section "Mechanical General Requirements."
   2. Division 23 Section "Nonmetal Ducts" for fabric ducts, fibrous-glass ducts, thermoset FRP ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
   3. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, relief air, and exhaust air-distribution systems in pressure classes from minus 6- to plus 6-inch wg.

1.3 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.
B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.
C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.

1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Application Schedule" Article.

1.6 ACTION SUBMITTALS

A. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts. Shop drawings shall be reviewed and approved by the Architect prior to any fabrication.
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Duct layout indicating sizes and pressure classes.
   3. Elevations of top and bottom of ducts.
   4. Dimensions of main duct runs from building grid lines.
   5. Fittings.
   6. Reinforcement and spacing.
   7. Seam and joint construction.
   8. Penetrations through fire-rated and other partitions.
   9. Equipment installation based on equipment being used on Project.
   10. Duct accessories, including access doors and panels.
   11. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.
B. Delegated-Design Submittal:
   1. Sheet metal thicknesses.
   2. Joint and seam construction and sealing.
   3. Reinforcement details and spacing.
   4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Other systems installed in same space as ducts.
   3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.

4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.8 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

1.9 QUALITY ASSURANCE

A. 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.
B. NFPA Compliance:
   1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
   2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.10 COORDINATION

A. Sheet metal trades shall cooperate fully with the Laboratory Airflow Controls Trades and shall attend all field installation training sessions.
B. Sheet metal trades shall cooperate fully with the Test and Balance Contractor and provide all miscellaneous caps and any other materials required for structural integrity and leakage testing of the complete duct system in whole or in part. Refer to Division 23 Section "Testing, Adjusting and Balancing."
   1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
C. Sheet metal trades shall participate in the above ceiling coordination program. Refer to Division 01 requirements.

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 SHEET METAL MATERIALS

A. 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: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
D. Tie Rods: For rectangular ducts having a side dimension of 48 inches or greater. Galvanized steel, 3/8-inch minimum diameter.

2.3 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
   1. Manufacturers:
      a. CertainTeed Corp.; Insulation Group.
      b. Johns Manville International, Inc.

c. Knauf Fiber Glass GmbH.

2. Materials: ASTM C 1071, Type I, flexible; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
   a. Thickness: 1 inch.
   b. Density: 1-1/2 pounds per cubic foot.
   c. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
   d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   e. Maximum Operating Temperature: 250 deg F when tested according to ASTM C 411.
   f. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   g. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
      1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
      2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
      3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

3. Noise reduction coefficient (NRC): Sound absorption coefficients shall not be less than those in the table below as tested by ASTM C423 using an ASTM E795 Type A mounting.

	Sound absorption coefficients at octave band center frequencies, Hz						
Thickness Inches (mm)	125	250	500	1000	2000	4000	NRC
1 (25)	.08	.31	.59	.84	.91	.90	.70

2.4 SEALANTS 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. Elastomeric Sealant Tape: 3 inches wide; modified butyl adhesive backed.
   1. Manufacturers:
      a. Hardcast; Foil-Grip 1402 and Foil-Grip 1402-181BFX.

C. Water-Based Joint and Seam Sealant:
   1. Manufacturers:
      a. Hardcast; Flex-Grip 550 and Versa-Grip 181.
      b. Polymer Adhesives; No. 11.
      c. United McGill.
   2. Application Method: Brush on.
   3. Solids Content: Minimum 65 percent.
   4. Shore A Hardness: Minimum 20.
   5. Water resistant.
   6. Mold and mildew resistant.
   7. VOC: Maximum 75 g/L (less water).
   8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   9. Service: Indoor or outdoor.

10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:
   1. Manufacturers:
      a. Hardcast; Sure-Grip 404.
      b. United McGill.
   2. Application Method: Brush on.
   3. Base: Synthetic rubber resin.
   4. Solvent: Toluene and heptane.
   5. Solids Content: Minimum 60 percent.
   6. Shore A Hardness: Minimum 60.
   7. Water resistant.
   8. Mold and mildew resistant.
   9. VOC: Maximum 395 g/L.
   10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
   11. Service: Indoor or outdoor.
   12. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.

E. 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.

F. Gaskets: Chloroprene elastomer, 40 durometer, 1/8 inch thick, full face, one piece vulcanized or dovetailed at joints.

G. 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.

2.5 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
   1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
   2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
   3. 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."
   4. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Attachments for stainless steel and PVC-coated duct shall be stainless steel.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
   3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

E. Load Rated Cable Suspension System: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.
   1. Cable: Aircraft quality 7 x 7 and 7 x 19 wire rope.
      a. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
      b. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
   2. Fastener: One-piece, die-cast zinc housing with Type 302 S26 stainless steel hardened and tempered springs, and oil impregnated, sintered, hardened and tempered steel locking wedges.
   3. End Fixings: Loop, stud or toggle; or plain end suitable for wire rope beam clamp.
   4. Manufacturers:
      a. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
      b. Duro Dyne Corp.; Dyna-Tite System.
      c. Gripple Inc.; Hang-Fast System.

F. Welded Supports: Structural steel shapes with zinc rich paint. Equivalent, proprietary design, rolled steel structural support systems may be used in lieu of mill rolled structural steel.

2.6 ROOF MOUNTED DUCT SUPPORTS

A. General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted duct.

B. Support: Assembly of bases, and vertical and horizontal members, for roof installation without membrane penetration.
   1. Manufacturer:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Eco Support Products.
c. MIFAB, Inc.; C-Port.
d. MIRO Industries.
e. Pentair Electrical & Fastening Solutions; CADDY.
f. Portable Pipe Hangers.

   2. Bases: Two or more plastic, stainless steel, or recycled rubber.
   3. Vertical Members: Two or more protective-coated-steel channels.
   4. Horizontal Member: Protective-coated-steel channel.

2.7 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
   3. Internal Tie Rod: Ducts having a side dimension of 48 inches or greater only.

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's and SMACNA guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
   1. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Nexus Inc.
      c. Ward Industries, Inc.

C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.8 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. 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.
B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
C. Butt transverse joints without gaps and coat joint with adhesive.
D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
F. 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.
G. 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:
    1. Fan discharges.
    2. Intervals of lined duct preceding unlined duct.
    3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.
H. Where double-wall rectangular duct is indicated:
    1. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
        a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
    2. 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.

2.9 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
B. Round and Flat-Oval, Spiral Lock-Seam Ducts:
    1. Manufacturers:
        a. Eastern Sheet Metal (ESM).
        b. Foremost Duct, LLC.
        c. LaPine Metal Products.
        d. Lindab Inc.
        e. McGill AirFlow Corporation.
        f. SEMCO Incorporated.
        g. Tangent Air, Inc.
        h. Universal Spiral Air.
C. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA “Industrial Duct Construction Standards” as required based on pressure class.

1. Round fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.

D. Flat-Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA “Industrial Duct Construction Standards” as required based on pressure class.
   1. Flat-oval fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.

E. Duct Joints:
   1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
   2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
   3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
   4. Bolts and fasteners for galvanized steel duct shall be carbon steel, zinc coated per ASTM A153. Bolts and fasteners for stainless steel and polyvinyl chloride coated steel duct shall be stainless steel.
   5. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
      a. Manufacturers:
         1) AccuDuct Mfg. Inc.
         2) Ductmate Industries, Inc.
         3) Eastern Sheet Metal (ESM).
         4) Lindab Inc.
         5) Universal Spiral Air.
   6. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
      a. Manufacturers:
         1) AccuDuct Mfg. Inc.
         2) Ductmate Industries, Inc.
         3) Eastern Sheet Metal (ESM).
         4) McGill AirFlow Corporation.
         5) SEMCO Incorporated.
         6) Universal Spiral Air.

F. Low Pressure Ductwork (plus or minus 2 inches W.G. Static Pressure Class)
   1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.
   2. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

G. Medium and High Pressure Ductwork (For Static Pressure Class Greater than plus or minus 2 inches W.G.)
   1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.
   2. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.
   3. Fabricate continuously welded medium and high pressure round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

4. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

H. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

I. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

J. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
   1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
   2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
      a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
      b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
      c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
      d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
   3. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
   4. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
   5. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
   6. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
   7. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
   8. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
   9. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
   10. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.
   11. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

2.10 DOUBLE-WALL ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Manufacturers:
   1. Eastern Sheet Metal (ESM).
   2. LaPine Metal Products.
   3. Lindab Inc.
   4. McGill AirFlow Corporation.
   5. SEMCO Incorporated.
   6. SET Duct Manufacturing, Inc.
   7. Tangent Air Inc.
   8. Universal Spiral Air.

B. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.
   1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
   2. Insulation: 2-inch- thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
      a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
   3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
      a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
      b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.
      c. Ducts 44 to 60 Inches in Diameter: 0.022 inch with single-rib spiral-seam construction.
      d. Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.
   4. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch- diameter perforations, with overall open area of 23 percent.
      a. Provide 1 mil mylar liner between acoustical insulation and perforated inner liner.
   5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.
   1. Solid Inner Ducts: Use the following sheet metal thicknesses:
      a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
      b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
      c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.
   2. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch- diameter perforations, with overall open area of 23 percent.

PART 3 - EXECUTION

3.1 DUCTWORK APPLICATION SCHEDULE

A. Ductwork materials and performance requirements are scheduled on the Drawing.

3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
C. Install ducts with fewest possible joints.
D. Install fabricated fittings for changes in directions, size, and shape and for connections.
E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
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. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, and sleeves. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories."
O. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes.
P. Protect existing duct interiors from moisture, construction debris and dust, and other foreign materials.
Q. Protect duct interiors from the elements and foreign materials until building is enclosed.
    1. Follow SMACNA's "Duct Cleanliness for New Construction," basic level.

3.3 EQUIPMENT INSTALLATION

A. Install venturi terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance. Refer to details for additional requirements.

3.4 DUCT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated. Ducts must be properly cleaned and sealed in strict accordance with sealant manufacturer’s instructions.
    1. Seal Class: Refer to Application Schedule on the Drawings.
    2. Seal ducts before external insulation is applied.
    3. After pressure testing, remake leaking joints until leakage is equal to or less than maximum allowable. Refer to Application Schedule on the Drawings for allowable leakage rates.

3.5 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
C. Install concrete inserts before placing concrete.
D. Support ductwork from building structure, not from roof deck, floor slab, pipe, other ducts, or equipment.
E. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
F. Install roof mounted duct supports in accordance with manufacturer’s instructions. Provide additional membrane layer or walkpads under support bases as required.
G. Use load rated cable suspension system for round duct in exposed locations.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."
B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 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.

3.8 FIELD QUALITY CONTROL

A. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
B. Duct system will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.

3.9 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 3113

SECTION 23 3116
NONMETAL 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with SMACNA's "Fibrous Glass Duct Construction Standards" and performance requirements and design criteria indicated.
   1. Static-Pressure Classes:
      a. Return Ducts (Negative Pressure).

1.3 DEFINITIONS

A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula Btu x in./h x sq. ft. x deg F at temperature differences specified. Values are expressed as Btu.
   1. Example: Apparent Thermal Conductivity (k-Value): 0.26.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Fibrous-glass duct materials.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for nonmetal ducts.
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Duct layout indicating sizes and pressure classes.
   3. Elevations of top and bottom of ducts.

4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcements and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, vibration isolation.

B. Delegated-Design Submittal:

1. Duct materials and thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Design Calculations: Calculations for selecting hangers and supports.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. NFPA Compliance:
1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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 FIBROUS-GLASS DUCTS

A. Manufacturers:
1. CertainTeed Corporation; HVAC Insulation Group.
2. Johns Manville International, Inc.
3. Knauf Fiber Glass GmbH.
4. Owens Corning.

B. Materials:
1. Glass fibers bonded with thermosetting resin.
2. Facing: Fire-resistive, reinforced, foil-scrim-kraft barrier.
3. Air-Side Surface: Treated to prevent erosion of fibers by air movement.
4. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
5. Required Markings: EI-rating, UL label, and other markings required by UL 181 on each full sheet of duct board; UL ratings for closure materials.

6. Moisture Absorption: Not exceeding 5 percent by weight at 120 deg F and 95 percent relative humidity for 96 hours when tested according to ASTM C 1104/C 1104M.
7. Vapor-Barrier Permeability: 0.02 perms maximum when tested according to ASTM E 96, Procedure A.
8. Noise-Reduction Coefficient: 0.65 minimum when tested according to ASTM C 423, Mounting A.
9. Temperature Limits: 250 deg F inside ducts; 150 deg F ambient temperature surrounding ducts.
10. Fabrication: Fabricate and assemble ducts according to SMACNA's "Fibrous Glass Duct Construction Standards."

C. Duct Boards: Rigid, rectangular, fibrous-glass boards with edge treatment; factory molded and faced on one side with fire-resistive, reinforced, foil-scrim-kraft barrier.
1. Flexural Rigidity (EI): 475, standard duty.
2. Thickness: 1 inch.

D. Reinforcements:
1. Channel Reinforcements for Ducts with a Maximum ID of 60 Inches or Less: Channels formed from 0.034-inch- thick, galvanized sheet metal with ASTM A 653/A 653M, G60 coating designation.
2. Channel Reinforcements for Ducts with a Maximum ID Larger Than 60 Inches: Channels formed from 0.052-inch- thick, galvanized sheet metal with ASTM A 653/A 653M, G60 coating designation.
3. Tie-Rod Reinforcements: 0.108-inch galvanized-steel wire, of length to suit termination method.
4. Reinforcing Rod Washers: 2-1/2-inch- square by 0.028-inch- thick, galvanized-steel washer with turned edges and volcano-type center hole.
5. Sag-Control Supports: 1/2-inch galvanized-steel conduit.

E. Closure Materials:
1. Pressure-Sensitive Tape: Comply with UL 181A; imprinted by the manufacturer with the coding "181A-P," the manufacturer's name, and a date code.
   a. Tape: Aluminum foil-scrim tape imprinted with listing information.
   b. Minimum Tape Width: 2-1/2 inches; 3 inches for duct board thicker than 1 inch.
   c. Staples: 1/2-inch outward clinching, 2 inches o.c. in tabs, one tab per joint.
   d. Water resistant.
   e. Mold and mildew resistant.

F. Hangers and Supports:
1. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
2. Hanger Materials: Galvanized sheet steel; galvanized-steel hanger wire; and galvanized-steel channels.

G. Shop Fabrication: Comply with SMACNA's "Fibrous Glass Duct Construction Standards."
1. Fabricate rectangular and 10-sided ducts and fittings from duct boards.
2. Fabricate mitered elbows with turning vanes.
3. Fabricate 90-degree branch connections from supply ducts with volume-control dampers in branch ducts.
4. Attach metal components to fibrous-glass ducts with galvanized-steel washers on opposite surfaces of duct walls.

2.3 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Attachments for stainless steel and PVC-coated duct shall be stainless steel.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

E. Load Rated Cable Suspension System: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.
1. Cable: Aircraft quality zinc coated 7 x 7 and 7 x 19 wire rope.
2. Fastener: One-piece, die-cast zinc housing with Type 302 S26 stainless steel hardened and tempered springs, and oil impregnated, sintered, hardened and tempered steel locking wedges.
3. End Fixings: Loop, stud or toggle; or plain end suitable for wire rope beam clamp.
4. Manufacturers:
a. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
b. Duro Dyne Corp.; Dyna-Tite System.
c. Gripple Inc.; Hang-Fast System.

F. Welded Supports: Structural steel shapes with zinc rich paint. Equivalent, proprietary design, rolled steel structural support systems may be used in lieu of mill rolled structural steel.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install nonmetal duct where indicated and as detailed on Drawings.

B. Install ducts with fewest possible joints.

C. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

D. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

E. Install ducts with a clearance of 1 inch.

F. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

G. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts with sheet metal flanges. Overlap opening on 4 sides by at least 1-1/2 inches.

H. Install fibrous-glass ducts and fittings according to SMACNA's "Fibrous Glass Duct Construction Standards".

I. Field fabricate fibrous-glass ducts according to SMACNA's "Fibrous Glass Duct Construction Standards."
1. Fabricate rectangular and 10-sided ducts and fittings from duct boards.
2. Fabricate mitered elbows with turning vanes.
3. Fabricate 90-degree branch connections from supply ducts with volume-control dampers in branch ducts.

4. Attach metal components to fibrous-glass ducts with galvanized-steel washers on opposite surfaces of duct walls.
5. Closure: Construct seams and joints according to NAIMA AH116.
6. Install reinforcements according to SMACNA's "Fibrous Glass Duct Construction Standards."
7. Support rigid round and rectangular ducts according to SMACNA's "Fibrous Glass Duct Construction Standards."
8. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

3.2 HANGER AND SUPPORT INSTALLATION

A. Duct Attachments: Support horizontal ducts with trapeze-type hangers.
B. Hangers: Suspend duct attachments from building attachments with one of the following hanger types:
   1. Galvanized sheet metal strips, a minimum of 0.034 by 1 inch wide.
   2. Galvanized-steel rods, 1/4 inch in diameter, threaded along entire length.
   3. Load rated cable suspension system.
C. Attach hangers to joints and reinforcing channels that occur within required hanger spacing. Attach hangers to transmit load to sides and bottom channels and no more than 6 inches from sides of ducts.
D. Support equipment and metal duct components and accessories independent of ducts.
E. Support terminal components separately.
F. Install sheet metal sleeves to support dampers. For motorized dampers, extend sleeves to support operators.
G. 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.
   1. 40 feet 80 feet 12 feet.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Inspect fibrous-glass duct systems according to "Inspection Checklist for Fibrous Glass Duct System Installation" in NAIMA AH116. Prepare a written report using the format of this checklist.
C. Duct system will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

END OF SECTION 23 3116

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SECTION 23 3300
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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 23 Section “Testing, Adjusting, and Balancing” for duct test holes.
   3. Division 23 Section “Temperature Controls” for motorized control dampers.
   4. Division 28 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

1.2 DEFINITIONS

A. NVLAP: National Voluntary Laboratory Accreditation Program.

B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.

C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.

D. High Pressure: Greater than 6 inch WG to 12 inch WG and velocities greater than 2,500 fpm. Construct for 12 inch WG positive or negative static pressure.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For turning vanes, include data for pressure loss generated sound power levels.
   2. For duct silencers, include pressure drop and dynamic insertion loss data.
B. 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: Power, signal, and control wiring.
C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.
D. Source quality-control reports.
E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
B. Comply with AMCA 500-D testing for damper rating.

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 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
C. Stainless Steel: ASTM A 480/A 480M, Types 304 and 316 as indicated.
D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.
F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

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.
H. Tie Rods: Stainless steel, 1/4-inch diameter for lengths 36 inches or less; 3/8-inch diameter for lengths longer than 36 inches for use in ducts in humid or corrosive atmospheres.
I. Bird Screens: No. 2 mesh, 0.063 inch diameter galvanized wire screen with open area of not less than 72 percent. Conceal sharp edges by adding metal edging consisting of rod, flat or angle iron, or 16 gage galvanized sheet steel turned over at least 3/4 inch on both sides.

2.3 PRESSURE RELIEF DOORS

A. Manufacturers:
   1. Kees Incorporated.
   2. Pottorff; a division of PCI Industries.
   3. Ruskin Company.
B. Description: Designed to open automatically to prevent exploding or imploding ductwork in the event dampers close while fan is still operating. Doors open outward for positive pressure relief, or inward for negative pressure relief.
C. Frame: 12 gage galvanized steel.
D. Door: 12 gage galvanized steel.
E. Seal: Polyurethane foam around door perimeter.
F. Pressure Relief Setting: Factory set, field adjustable, minimum 1.0 inch wg (250 Pa) above normal system pressure.
G. Springs: Negator springs for door closure upon pressure relief and system shutdown.
H. Temperature Limits: Minus 40 deg F minimum, and 120 deg F maximum.

2.4 LOW PRESSURE MANUAL VOLUME DAMPERS

A. Manufacturers:
   1. American Warming and Ventilating.
   2. Arrow United Industries.
   3. Greenheck.
   4. Krueger.
   5. Louvers and Dampers.
   6. Nailor Industries Inc.
   7. Ruskin Company.
   8. Vent Products Company, Inc.
   9. Young Regulator Company.
B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
   1. Except for dampers in round ductwork sized 12 inches and smaller, provide end bearings.
C. Rectangular Volume Dampers: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.
D. Round Volume Dampers 16-inch Diameter and Smaller: Single-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.
E. Round Volume Dampers Larger than 16-inch Diameter: Multiple-opposed-blade design AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.
F. Damper Materials:
   1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated

for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Blade Axles: Galvanized steel.
4. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve type.
5. Tie Bars and Brackets: Galvanized steel.

G. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

H. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 MEDIUM OR HIGH PRESSURE MANUAL VOLUME DAMPERS

A. Manufacturers:
1. American Warming and Ventilating.
2. Greenheck.
3. Louvers and Dampers.
4. Nailor Industries Inc.
5. Ruskin Company.
6. Vent Products Company, Inc.

B. General Description: Factory fabricated, galvanized steel or extruded aluminum construction, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

C. Rectangular Volume Dampers: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications. Construction and assembly such that no noise producing blade vibration occurs at velocities 20 percent greater than maximum system design velocity.

D. Round Volume Dampers 16-inch Diameter and Smaller: Single-blade, or multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications. Construction and assembly such that no noise producing blade vibration occurs at velocities 20 percent greater than maximum system design velocity.

E. Round Volume Dampers Larger than 16-inch Diameter: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications. Construction and assembly such that no noise producing blade vibration occurs at velocities 20 percent greater than maximum system design velocity.

F. Damper Materials:
1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
5. Blade Axles: Galvanized steel or stainless steel.

6. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve type.
7. Tie Bars and Brackets: Aluminum or galvanized steel.

G. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

H. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.6 MOTORIZED CONTROL DAMPERS

A. Refer to Division 23 Section “Temperature Controls.”

2.7 BLAST GATES

A. Manufacturers:
1. Dixie Sheet Metal.
2. LaPine Metal Products.
3. Semco.

B. Full-body style, factory fabricated of minimum 18 gage, galvanized sheet metal.

2.8 UPBLAST DAMPERS

A. Manufacturers:
1. Dixie Sheet Metal.
2. Shipman Industries, Inc.

B. Construction:
1. Stack Cap Damper: 20 gage galvanized steel.
2. Windband: 18 gage galvanized steel, designed to prevent wind resistance from impairing damper operation.
3. Axle: 1/2 inch diameter with bronze bearings.
4. Include cushion close neoprene gasket, and rubber stops to eliminate rattles and protect dampers during fan operation.
5. Damper unit shall be provided with discharge bird screen.

2.9 FIRE DAMPERS (CURTAIN STYLE)

A. Manufacturers:
1. Air Balance, Inc.
2. Greenheck.
3. NCA Manufacturing, Inc.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Dynamic fire dampers with curtain style blades, and labeled according to UL 555, maximum velocity 2000 fpm, maximum static pressure 4 inches w.g.

C. Fire Rating:
1. 1-1/2 hours for 2 hour rated walls.
2. 3 hours for 4 hour rated walls.

D. Frame: Type B or Type C Curtain type with blades outside airstream; fabricated with roll-formed, galvanized steel in gages required by manufacturer’s UL listing; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.

2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. 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.

H. Fusible Links: Replaceable, 286 deg F rated.

2.10 SMOKE DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. Greenheck.
   3. Nailor Industries Inc.
   4. NCA Manufacturing, Inc.
   5. Ruskin Company.

B. General Description: Smoke dampers with airfoil blades, labeled according to UL 555S, with minimum Class II leakage rating.

C. Frame and Blades: 16 gage, galvanized sheet steel.

D. Mounting Sleeve: Factory-installed, galvanized sheet steel.
   1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.

E. Rated pressure and velocity to exceed design airflow conditions.

F. Damper Actuators: Electric modulating or two-position action as required.
   1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   2. Size for torque required for damper seal at load conditions.
   3. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
   4. 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.
   5. Power Requirements (Two-Position Spring Return): 24 or 120 V ac.
   6. Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc holding.
   7. Proportional Actuators (24V ac/dc): Control signal shall be 0-10vdc, 2-10vdc or 4-20mA as required to operate with associated controller. Include position feedback signal for 0-10vdc, 2-10vdc or 4-20mA as required to be monitored by associated controller.
   8. Actuator timing shall meet 15 sec.
   9. Temperature Rating: Actuator shall have a UL555S listing by the damper manufacturer for 250 deg F.

G. Damper blade position end switches: Factory installed damper position switch package for both full open and full closed indication (equivalent to Ruskin SP100 switch package).

H. Test Switch: Damper mounted momentary “test” push-button switch rated for 24V or 120V as required to allow testing and/or maintenance of motorized dampers.
   1. Include damper mounted “open” and “closed” indication lights on switch plate for connection to factory installed damper blade position end switches.

2.11 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.

2. Greenheck.
3. Nailor Industries Inc.
4. NCA Manufacturing, Inc.
5. Ruskin Company.

B. General Description: Combination fire and smoke dampers shall be labeled according to UL 555 and UL 555S. Leakage shall not exceed 10 cfm per square foot at 1 inch WG differential pressure (Leakage Class II).

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating:
    1. 1-1/2 hours for 2 hour rated walls.
    2. 3 hours for 4 hour rated walls.

E. Frame and Blades: 0.064-inch- thick, galvanized sheet steel.

F. Mounting Sleeve: Factory-installed, galvanized sheet steel.
    1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Damper Actuators: Electric modulating or two-position action as required.
    1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
    2. Size for torque required for damper seal at load conditions.
    3. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
    4. 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.
    5. Power Requirements (Two-Position Spring Return): 24 or 120 V ac.
    6. Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc holding.
    7. Proportional Actuators (24V ac/dc): Control signal shall be 0-10vdc, 2-10vdc or 4-20mA as required to operate with associated controller. Include position feedback signal for 0-10vdc, 2-10vdc or 4-20mA as required to be monitored by associated controller.
    8. Actuator timing shall meet 15 sec.
    9. Temperature Rating: Actuator shall have a UL555S listing by the damper manufacturer for 250 deg F.

I. Manual Heat Responsive Fuse Link with Reset and Damper Blade Position End Switches: Factory installed manual heat responsive fuse link with reset switch / damper position switch package for both full open and full closed indication (equivalent to Ruskin TS150 switch package.

J. Test Switch: Damper mounted momentary “test” push-button switch rated for 24V or 120V as required to allow testing and/or maintenance of motorized dampers.
    1. Include damper mounted “open” and “closed” indication lights on switch plate for connection to factory installed damper blade position end switches.

2.12 DUCT SILENCERS (FIBERGLASS FILL)

A. Manufacturers:
    1. Industrial Acoustics Co. Inc.
    2. Price Industries.
    3. Ruskin Company.
    4. VAW Systems Ltd.
    5. Vibro-Acoustics.

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.

C. Rectangular Units: Unless otherwise scheduled on the Drawings, fabricate casings with a minimum of 20 gage, solid galvanized sheet metal for outer casing and 22 gage, ASTM A 653/A 653M, G90, perforated galvanized sheet metal for inner casing.

D. Round Units: Unless otherwise scheduled on the Drawings:
   1. Outer Casings:
      a. ASTM A 653/A 653M, G90, galvanized sheet steel.
      b. Up to 8 Inches in Diameter: 24 gage.
      c. 9 through 22 Inches in Diameter: 22 gage.
      d. 24 through 36 Inches in Diameter: 20 gage.
      e. 38 through 50 Inches in Diameter: 18 gage.
      f. 52 through 60 Inches in Diameter: 16 gage.
      g. Casings fabricated of spiral lock-seam duct may be one gage thinner than that indicated.
   2. Interior Casing, Partitions, and Baffles:
      a. ASTM A 653/A 653M, G90, galvanized sheet steel.
      b. At least 24 gage thick and designed for minimum aerodynamic losses.

E. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.

F. Fill Material: Inert and vermin-proof fibrous glass material, packed under not less than 5 percent compression.
   1. Erosion Barrier: Fiberglass cloth.
      a. Return fan inlet and outlet silencer fill do not require an erosion barrier.

G. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.
   1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
   2. Lock form and seal or continuously weld joints.
   3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
   4. Reinforcement: Cross or trapeze angles for rigid suspension.

H. Source Quality Control:
   1. Acoustic Performance: Test according to ASTM E 477.
      a. Tests performed in NVLAP accredited laboratory.
      b. Include accreditation certificate with submittals.
      c. Submittals from non-NVLAP accredited facilities will not be accepted.
   2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-fpm face velocity.
   3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.13 TURNING VANES

A. Manufactured Turning Vanes:
   1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
   2. Double-vane or airfoil-shaped, curved blades of galvanized sheet steel set into vane runners suitable for duct mounting.
   3. Generated sound power level shall not exceed 54 decibels in octave band 4 at 2000 fpm in a 24-inch by 24-inch duct.
   4. Manufacturers:
      a. Aero/Dyne Company; H-E-P Turning Vanes.
      b. Ductmate Industries, Inc.
      c. Duro Dyne Corp.

d. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Acoustic Turning Vanes:
   1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
   2. Double-vane curved blades of galvanized sheet steel with perforated faces and fibrous-glass fill set into vane runners suitable for duct mounting.
   3. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2.14 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class. Doors may be field fabricated in accordance with SMACNA Standards, or commercially produced.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.
   1. Manufacturers:
      a. Air Balance, Inc.
      b. Greenheck.
      c. Nailor Industries Inc.
      d. Ruskin Company.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Provide number of hinges and locks as follows:
      a. Less Than 12 Inches Square: Secure with two sash locks.
      b. Up to 18 Inches Square: Two hinges and two compression locks.
      c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
      d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.
   1. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Flexmaster U.S.A., Inc.
   2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.15 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. ADSCO Manufacturing LLC.
   2. Duro Dyne Corp.
   3. Senior Flexonics Pathway.
   4. Ventfabrics, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip minimum 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. Select metal compatible with ducts.

D. 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 20 to plus 200 deg F.

E. 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.

2.16 FLEXIBLE DUCTS, LOW AND MEDIUM PRESSURE

A. Manufacturers:
   1. Flexmaster U.S.A., Inc.; a Masterduct Company; Type 1M, Acoustical.
   2. Hart & Cooley.
   3. Thermaflex; part of the Flexible Technologies Group.

B. Flexible Ducts: Interlocking spiral of galvanized steel or aluminum construction or fabric supported by helically wound spring steel wire or flat steel bands; rated to 6 inches WG positive and 4 inches WG negative for low and medium pressure ducts.

C. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by a fire retardant polyethylene vapor barrier jacket; maximum 0.23 K value at 75 deg F.

D. Acoustical performance tested in accordance with the Air Diffusion Council's *Flexible Air Duct Test Code FD 72-R1, Section 3.0, Sound Properties* shall be as follows:

The insertion loss (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	8	32	38	35	39	25
8" diameter	13	32	36	35	36	21
12" diameter	15	29	28	33	26	14

The radiated noise reduction (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	6	8	7	8	9	13
8" diameter	9	6	6	7	8	10
12" diameter	9	7	6	6	8	11

The self generated sound power levels (LW) dB are 10-12 Watt of a 10 foot length of straight duct for an empty sheet metal duct when tested in accordance with ASTM E477, at a velocity of 1000 feet per minute, shall not exceed:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	42	31	23	18	17	21
8" diameter	41	34	27	19	18	21
12" diameter	53	44	36	27	21	22

E. Flexible Duct Fittings: Galvanized steel, twist-in design with damper. Size as indicated.

F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.17 FLEXIBLE DUCTS HIGH PRESSURE

A. Manufacturers:
   1. Flexmaster U.S.A., Inc.; a Masterduct Company; Type 3M.
   2. Hart & Cooley.
   3. Thermaflex; part of the Flexible Technologies Group.

B. Flexible Ducts: Interlocking spiral of galvanized steel or aluminum construction or fabric supported by helically wound spring steel wire or flat steel bands; rated to 12 inches WG positive and 4 inches WG negative for medium and high pressure ducts.
A. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 deg F.
B. Flexible Duct Fittings: Galvanized steel, twisted-in design with damper. Size as indicated.
C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.18 FLEXIBLE DUCT ELBOW SUPPORTS

A. Manufacturer:
   1. Thermaflex; part of the Flexible Technologies Group; FlexFlow Elbow.
   2. Smart Air & Energy Solutions; SMART Flow Elbow.
B. Elbow supports shall be constructed of durable composite material and be fully adjustable to support flexible duct diameters 6 inches through 16 inches.
C. Elbow supports shall be UL listed for use in return air plenum spaces.

2.19 DUCT ACCESSORY HARDWARE

A. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND 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. Provide 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 PVC coated ducts; and aluminum accessories in aluminum ducts.
C. Install control 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 stainless steel volume dampers in stainless steel ducts.
   3. Install aluminum volume dampers in aluminum ducts.
E. Set dampers to fully open position before testing, adjusting, and balancing.
F. Install fire dampers, combination fire and smoke dampers, and smoke dampers according to UL listing.
G. Install duct silencers rigidly to ducts.
H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On upstream side of duct coils.
   2. Upstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links.

7. Control devices requiring inspection.
8. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.
J. Install duct-mounting, rectangular access doors with long dimension at right angles to direction of airflow and of largest standard size which can be accommodated in duct. Maximum size: 21 by 14 inches.
K. Install pressure relief doors vertically and level in accordance with manufacturer's instructions, between the fan and first operable damper.
L. Label access doors according to Division 20 Section "Mechanical Identification."
M. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
N. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
O. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
P. Connect diffusers or light troffer boots to low pressure ducts flexible duct clamped or strapped in place.
Q. Connect flexible ducts to metal ducts with draw bands. Flexible duct connections must be installed with draw bands and the manufacturers required or recommended installation methods
R. Install flexible duct elbow supports at each diffuser, grille, or register, and elsewhere as indicated.
S. Install turning vanes in rectangular duct elbows in excess of 45 degrees, and where indicated:
   1. Use manufactured double-vane turning vanes unless otherwise specified.
   2. Seat outboard-most vane in heal of duct elbow.
   3. Provide vanes for all runner punchings, practice of eliminating every other vane is prohibited.
   4. Use single-vane turning vanes in low pressure square elbows.

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.

3.3 ADJUSTING

A. Adjust duct accessories for proper settings.
B. Adjust fire dampers, combination fire and smoke dampers, and smoke dampers for proper action.
C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 3300

SECTION 23 3413
AXIAL 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air moving equipment.
   4. Division 23 Section “Power Ventilators” for axial roof ventilators.

1.2 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:
   1. Operating Limits: Classify according to AMCA 99.

1.3 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 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 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 an NRTL 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.

1.5 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.

1.6 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.

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. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MIXED-FLOW FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerovent; a division of Twin City Fan Companies, Ltd.; QSL.
   2. American Fan; Flakt Woods Inc.; MX
   3. Greenheck; QEI.
   4. Loren Cook Company; QMX.
   5. PennBarry; a unit of Tomkins PLC; ESI.
B. Description: Fan wheel and housing, factory-mounted motor with belt drive, and accessories.
C. Housings: Welded, heavy-gage steel Galvanized steel.
   1. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
   2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.

D. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.
E. Drives: Factory mounted, with final alignment and adjustment made after installation. Refer to Division 23 Section “Common Work Results for HVAC” for additional requirements.
F. Accessories:
    1. Mounting Clips: Horizontal base mounting clips welded to fan housing, of same material as housing.
    2. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork of same material as housing.
    3. Backdraft Dampers: Butterfly style, for mounting with flexible connection to the discharge of fan or direct mounted to the discharge diffuser section of same material as housing.
    4. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
    5. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
    6. Inlet Cones: Round-to-round transition of same material as housing.
    7. Outlet Cones: Round-to-round transition of same material as housing.
    8. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
G. Motors: Comply with requirements in Division 20 Section "Motors."
H. Factory Finishes:
    1. Sheet Metal Parts: Prime coat before final assembly.
    2. Exterior Surfaces: Baked-enamel finish coat after assembly.
I. Capacities and Characteristics: Refer to schedule(s) on Drawings.
J. Sound Power and Level Ratings:
    1. Ducted Fans: Rated in accordance with AMCA 301 when tested in accordance with AMCA 300.
    2. Non-Ducted Fans: Rated in accordance with AMCA 301 in zones at 5 feet from acoustic center of fan, tested in accordance with AMCA 300 and converted in accordance with AMCA 302.
K. Vibration Isolators: Spring isolators having a static deflection of 1.5 inch. Refer to Division 20 Section “Mechanical Vibration Controls” for additional requirements.

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 grade floor-mounting units using spring isolators having a static deflection of 1.5 inch. Vibration control devices are specified in Division 20 Section "Mechanical Vibration Controls."
    1. Secure vibration controls to concrete floors using anchor bolts.
C. Install units with clearances for service and maintenance.
D. Label fans according to requirements specified in Division 20 Section "Mechanical Identification."

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 "Duct Accessories."
B. Ground equipment according to Division 26 Section "Grounding and Bonding."
C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
    1. Verify that shipping, blocking, and bracing are removed.
    2. Verify unit is secure on mountings and supporting devices and 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 23 3413

SECTION 23 3416
CENTRIFUGAL 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Motors.”
   3. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air moving equipment.

1.2 SUMMARY

A. This Section includes replacement fans for air-handling units and similar equipment.

1.3 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:
   1. Operating Limits: Classify according to AMCA 99.

1.4 ACTION 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.

1.5 INFORMATIONAL SUBMITTALS

A. 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 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.

B. 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.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For centrifugal fans to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL 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.

1.8 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 the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.9 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.

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. Belts: One set for each belt-driven unit.
   2. Sheaves: For fan speed adjustment, sheave size determined at time of air quantity balancing operation, one set for each multiple belt-driven, non-VFC unit.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace all components of the fans that fail in materials or workmanship within 60 months from date of project acceptance. Warranty shall include all parts, labor, travel time and expenses.

B. Contractor shall troubleshoot issues within 24 hours of notification by the Owner.

C. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the

event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing.
   2. Aerovent; a Twin City Fan Company.
   3. Chicago Blower Corporation.
   4. Loren Cook Company.
   5. PennBarry; Division of Air System Components.

B. General: Select fans to avoid instability in service and compute outlet areas to outlet velocities in accordance with AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency.

C. Description: AMCA certified, factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

D. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.
   1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   2. Spun inlet cone with flange.
   3. Outlet flange.

E. Fan Wheels: Airfoil, backward-inclined, or forward-curved as indicated on Drawings.
   1. Airfoil Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
   2. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades and fastened to shaft with set screws.
   3. Forward-Curved Wheels: Black-enameled or galvanized steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

F. Accessories:
   1. Scroll Access Doors: For fans larger than 18 inches in diameter, shaped to conform to scroll, with quick-opening latches and gaskets.
   2. Cleanout Door: Bolted gasketed door allowing access to fan scroll, of same material as housing.
   3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   4. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
   5. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

G. Motors: Comply with requirements in Division 20 Section "Motors."

H. Capacities And Characteristics:
   1. Refer to schedules on the Drawings.
   2. Sound Power Level Ratings:

a. Ducted Fans: Rated in accordance with AMCA 301, when tested in accordance with AMCA 300.
b. Nonducted Fans: Rated in zones at 5 feet from acoustic center of fan and in accordance with AMCA 301, tested in accordance with AMCA 300 and converted to AMCA 302.

I. Fan Construction:
1. Housing Material: Reinforced steel. Metal thickness not less than minimum specified by AMCA for the class of service.
2. Wheel Material: Steel. Metal thickness not less than minimum specified by AMCA for the class of service.
3. Refer to schedules on Drawings for additional requirements.

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/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. Support floor-mounting units using vibration-control devices as specified in Division 20 Section "Mechanical Vibration Controls."
1. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.
2. Exception: Fan arrays that meet the balancing specification do not require spring isolation.
E. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
F. Install units with clearances for service and maintenance.
G. Label fans according to requirements specified in Division 20 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."
B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. 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. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 3416

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SECTION 23 3423
POWER VENTILATORS

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 Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Motors.”
   3. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air moving.

1.2 PERFORMANCE REQUIREMENTS

A. Classify according to AMCA 99.

1.3 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.
   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.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For power ventilators 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 an NRTL 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.

1.5 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 location, according to manufacturer's written instructions.
C. Lift and support units with manufacturer's designated lifting or supporting points.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.
B. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division 07 Section "Roof Accessories."

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.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of the fan that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Motors and Fans: Manufacturer's standard, but not less than five years from date of Project Acceptance.
   2. Contractor shall troubleshoot issues within 24 hours of notification by the Owner. Warranty shall include all parts, labor, travel time and expenses.

B. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

PART 2 - PRODUCTS

2.1 INLINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Mfg. Corp.
   2. Greenheck; Models SQ/BSQ.
   3. Loren Cook Company.
   4. PennBarry; a unit of Tomkins PLC
B. Description: In-line, direct drive centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
C. Casing: Rectangular or cylindrical, flanged.
D. Throat and Mounting Assembly: One-piece spun aluminum or continuously welded assembly.
   1. Stiffeners: Continuously welded.
   2. Bolts, nuts, rivets, and washers: Cadmium plated.
   3. Nuts: Self-locking type, vibration proof.
E. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
F. Fan Wheels: Aluminum, backward curved airfoil blades welded to aluminum hub.
G. Accessories:
   1. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
   2. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet for fan SG101-EF not connected to ductwork.
H. Capacities and Characteristics: Refer to schedule(s) on Drawings.
I. Vibration Isolators: Refer to Division 20 Section “Mechanical Vibration Controls.”

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Mfg. Corp.; Models PRN and PV.
   2. Greenheck; Models G and GB.
   3. Loren Cook Company; Models ACED and ACEB.
   4. PennBarry; a unit of Tomkins PLC
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.
D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
E. Accessories:
   1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   2. Bird Screens: Removable, 1/2-inchmesh, aluminum or brass wire.
F. Provide prefabricated roof curbs for each fan.
G. Capacities and Characteristics: Refer to schedule(s) on Drawings.

2.3 UPBLAST CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Manufacturing; Acme Fan Group.
2. Aerovent; a Twin City Fan Company.
3. Greenheck Fan Corporation; CUE Series.
4. Loren Cook Company.
5. Moffitt Corporation.
6. PennBarry; Division of Air System Components; Fumex.

B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Spun-aluminum construction with square, one-piece, aluminum base with venturi inlet cone. Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Provide prefabricated roof curbs for each fan.

G. Capacities and Characteristics: Refer to schedule(s) on Drawings.

2.4 PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Mfg. Corp.
2. Greenheck.
3. Loren Cook Company.

B. Description: Belt 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. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

E. Belt-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 and belt adjustment made after installation.

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Sheaves: Cast iron with split, tapered bushing; dynamically balanced at factory.
4. Motor Sheaves: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select sheave 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 of steel for motors mounted on outside of fan cabinet.
7. Refer to Division 23 Section “Common Work results for HVAC” for additional requirements.

F. Accessories:

1. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
2. Wall Sleeve: Galvanized steel to match fan and accessory size.
3. Variable-Speed Controller for EF-6: Solid-state control to reduce speed from 100 to 25 percent as scheduled. Refer to Division 23 Section "Variable Frequency Controllers."
4. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

G. Capacities and Characteristics: Refer to schedule(s) on Drawings.
H. Vibration Isolators: Refer to Division 20 Section "Mechanical Vibration Controls."
I. Spark Arrestance Class: C.

2.5 UTILITY SET FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck; Series USF.
2. Acme Engineering & Manufacturing Corp.
3. Aerovent; a Twin City Fan Company.
4. Loren Cook Company.
5. PennBarry; a unit of Tomkins PLC.
6. Trane.

B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
C. Housing: Fabricated of steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
1. Housing Discharge Arrangement: Adjustable to eight standard positions.

D. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
1. Blade Materials: Steel.
2. Blade Type: Airfoil, backward inclined, or forward curved, depending on manufacturer's standard selection practice based on wheel size and anticipated fan performance.

E. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
F. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings. Refer to Division 20 Section "Mechanical General Requirements" for additional requirements.
G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
1. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
2. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
3. Refer to Division 23 Section "Common Work Results for HVAC" for additional requirements.

H. Accessories:
1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Motor and Drive Hoods: Stamped vents over motor and drive compartment.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Inlet Box: 360 degree orientation, with bolted access door.

I. Coatings: Parts in contact with airstream coated with color-match enamel.
J. Capacities and Characteristics: Refer to schedule(s) on Drawings.
K. Vibration Isolators: Refer to Division 20 Section "Mechanical Vibration Controls.
L. Spark Arrestance Class: B.

2.6 ROOF CURBS AND ACCESSORIES

A. Construction: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch chemically treated wood nailer. Size as required to suit roof opening and fan base.
   1. Manufacturers: Roof curbs shall be provided by the fan manufacturer, or one of the following:
      a. Creative Metals.
      b. Pate.
      c. Roof Products & Systems.
      d. ThyCurb.
      e. Any of the approved roof mounted exhaust fan manufacturers.
   2. Configuration: Self-flashing without a cant strip, with mounting flange, and suitable for flat roofs with tapered insulation.
   3. Height: Curb shall extend a minimum 18 inches above top surface of roof insulation.

B. Construction: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch chemically treated wood nailer. Size as required to suit roof opening and fan base.
   1. Manufacturers: Roof curbs shall be provided by the fan manufacturer, or one of the following:
      a. Creative Metals.
      b. Pate.
      c. Roof Products & Systems.
      d. ThyCurb.
      e. Any of the approved roof mounted exhaust fan manufacturers.
   2. Configuration: Built-in raised cant with step dimension matching insulation thickness, with mounting flange, and suitable for sloped roofs with uniform insulation thickness.
   3. Height: Curb shall extend a minimum 18 inches above top surface of roof insulation.

2.7 MOTORS

A. Comply with requirements in Division 20 Section "Motors."

2.8 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. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
C. Support suspended units from structure using threaded steel rods and spring hangers. Vibration-control devices are specified in Division 20 Section "Mechanical Vibration Controls
D. Install floor-mounting units as specified in Division 20 Section "Mechanical Vibration Controls."

E. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
F. Install units with clearances for service and maintenance.
G. Label units according to requirements specified in Division 20 Section "Mechanical Identification."

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 "Duct Accessories."
B. Install ducts adjacent to power ventilators to allow service and maintenance.
C. Ground equipment according to Division 26 Section "Grounding and Bonding."
D. Connect wiring according to Division 26 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, 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 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. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
D. Replace fan and motor sheaves as required to achieve design airflow.
E. Lubricate bearings.

END OF SECTION 23 3423

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SECTION 23 3500
SPECIAL EXHAUST 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. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Motors.”
   3. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air moving equipment.

1.2 PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. 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 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.

B. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For power ventilators 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, Article 100, by a NRTL 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.

1.7 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.

1.8 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.

1.9 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. Belts: One set for each belt-driven unit.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace all components of the exhaust systems that fail in materials or workmanship within 60 months from date of project acceptance. Warranty shall include all parts, labor, travel time and expenses.

B. Contractor shall troubleshoot issues within 24 hours of notification by the Owner.

C. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All

costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

PART 2 - PRODUCTS

2.1 DUST COLLECTORS (PROVIDED BY THE OWNER, INSTALLED BY CONTRACTOR)

A. Description: Completely self-contained fabric type unit consisting of a weatherproof collector housing, fan, motor, filter cartridges and automatic shaker. Include a funnel bottom for dust disposal. Overall construction shall be of galvanneal steel for maximum corrosion resistance. Exterior shall be finish coated for exterior installation. Cartridge and fan access shall be through full height doors with quick opening, flush latches. Include a 1/4 inch thick steel plate motor mounting bracket assembly with lifting lug openings.

B. Fan: Backwardly inclined for non-overloading operation constructed of aluminum and fitted with a scroll for maximum efficiency and quiet operation. Direct driven by 3600 rpm TEFC motor and both fan and motor shall be dynamically balanced for smooth vibration free operation. Outlet area lined with a strong, smooth fiberglass laminated mat for sound attenuation. Liner designed for operation at velocities up to 5000 fpm and temperatures up to 250 deg F and meeting fire resistance requirements of NFPA 90A and 90B.

C. Filter Cartridge: Consisting of individual pockets sewn from one piece of 8.2 ounce cotton sateen fabric, designed to deliver in excess of 90 percent efficiency by weight on fine industrial dusts. Cartridge shall have wide spacings consisting of 16 pockets for maximum application flexibility. Filter cartridges shall have rigid corrugated separators to prevent pocket collapse and to channel the cleaned air in a laminar flow profile into the fan inlet cone. Adjacent pockets shall be positioned by steel bars at the top and flat shaker fingers at the bottom to prevent mutual blank off and to maintain the dust cake collection area.

D. Cartridge fabric shall be fitted over a galvanized steel locking frame and all separators securely positioned by a galvanized steel retainer resulting in a tight pocket assembly to minimize pressure drop and maximize dust release. Each cartridge assembly shall be locked in place by two lever actuated over-center cam assemblies which force the steel header frame securely against a 3/4 inch x 1-1/2 inch neoprene gasket surface.

E. Shaking action shall be delivered by a horizontal contact system that distributes shaking force throughout the entire surface of each individual filter pocket. Pockets shall be held tightly by flat shaker fingers which impart an acceleration equal to a minimum of 7 G’s from a motorized eccentric driven shaker assembly. Operation of the automatic shaker shall be controlled by a printed circuit board using complimentary metal oxide, semi-conductor (CMOS) technology in a dual timer mode. Include fan delay cycle adjustable from 10 to 20 seconds and actual shaker cycle adjustable from 6 to 60 seconds.

F. Shaker control board shall have a suitable transformer and starter to match fan motor voltage. Panel factory installed in shaker enclosure and wired to shaker motor.

G. Funnel Bottom: Steep 45 degree funnel terminating in a 12 inch diameter drum connection device without gates or doors to permit immediate downflow of dislodged dust into the dust disposal container. Unit designed to accommodate and provided with standard 55 gallon drums with quick opening, positive locking device to prevent air or dust leakage.

2.2 MOTORS

A. Comply with requirements in Division 20 Section "Motors."

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 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 packaged exhausters and collectors level and plumb.
B. Vibration- control devices are specified in Division 20 Section "Mechanical Vibration Controls."
   1. Secure vibration 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 units with clearances for service and maintenance.
E. Label units according to requirements specified in Division 20 Section "Mechanical Identification."

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 "Duct Accessories."
B. Install ducts adjacent to packaged exhausters to allow service and maintenance.
C. Ground equipment according to Division 26 Section "Grounding and Bonding."
D. Connect wiring according to Division 26 Section "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. Report results in writing.
B. 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 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.

C. 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. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
D. Replace fan and motor pulleys as required to achieve design airflow.
E. Lubricate bearings.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain special exhaust systems and equipment.

END OF SECTION 23 3500

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SECTION 23 3600
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 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 23 Section “Metal Ducts.”
   3. Division 23 Section “Temperature Controls.”

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Liners and adhesives.
   2. Sealants and gaskets.

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. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on 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.

D. Operation and Maintenance Data: For air terminal units to include in operation and maintenance manuals. Include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.3 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 01 Section "Product Requirements."
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by NRTL 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."

1.4 COORDINATION

A. Coordinate layout and installation of air terminal units 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 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 SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers:
   1. Krueger-HVAC; Air Distribution Technologies, Inc.; a JCI Company.
   2. Nailor Industries, Inc.
   3. Price Industries.
   4. Titus; Air Distribution Technologies, Inc.; a JCI Company.
   5. Tuttle & Bailey; Air Distribution Technologies, Inc.; a JCI Company.
B. Configuration: Variable and constant volume, medium pressure terminal units with casing, 100 percent tight shutoff volume regulator, velocity sensor, and sound attenuating thermal insulation.
C. Casing: Constructed of 0.034-inch mill galvanized steel or 0.032-inch aluminum.
   1. Casing Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
   5. Access Door: Integral with unit and located upstream of heating coil. For access to heating coil, quarter turn sash latch construction, with gasket.
D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
E. Velocity Sensor: Multipoint averaging array. Sensor located in air inlet.

F. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
G. DDC Controls: Single-package unitary controller and actuator specified in Division 23 Section "Temperature Controls."
H. Control Sequence: Refer to Temperature Control Diagrams on Drawings.

2.3 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. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
D. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.4 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.
C. Acoustical Applications and Sound Evaluation: Based on ARI Standard 885-98, “Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 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 or structural-steel fasteners appropriate for construction materials to which hangers are being attached. Refer to Division 20 Section “Hangers and Supports” for additional information.
   1. Where practical, install concrete inserts before placing concrete.
C. Hangers Exposed to View: Threaded rod and angle or channel supports.
D. 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.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 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 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 terminal units according to Division 23 Section "Metal Ducts."
E. Ground units with electric heating coils according to Division 26 Section "Grounding and Bonding."
F. Connect wiring according to Division 26 Section "Conductors and Cables."

G. 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. 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. 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.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   2. Verify that controls and control enclosure are accessible.
   3. Verify that control connections are complete.
   4. Verify that nameplate and identification tag are visible.
   5. Verify that controls respond to inputs as specified.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 3600

SECTION 23 3713
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 1 Specification Sections, apply to this Section.

B. Related Sections include the following:
   1. Division 10 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   2. Division 20 Section “Mechanical General Requirements.”
   3. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

A. Product Data: For each 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. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on 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.

PART 2 - PRODUCTS

2.1 AIR DIFFUSION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Krueger-HVAC; Air Distribution Technologies, Inc.; a JCI Company.
   2. Nailor Industries, Inc.
   3. Price Industries.
   4. Titus; Air Distribution Technologies, Inc.; a JCI Company.

5. Tuttle & Bailey; Air Distribution Technologies, Inc.; a JCI Company.

B. Terminal air diffusion devices have been chosen in terms of specific air distribution requirements, spacing, and sound characteristics.
C. Provide plaster frames for units installed in plaster ceilings.
D. Provide gaskets for supply terminal air devices mounted in finished surfaces.
E. Air diffusion devices shall be standard off white baked enamel finish unless noted otherwise. Provide air diffusion device interior surfaces, including blank-offs, with black matte finish.
F. Air pattern adjustments shall be made from the face of the device.
G. Refer to drawings and schedules for quantities, types, and finishes.
H. Coordinate frame types with Architectural Reflected Ceiling Plan.

2.2 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."
B. Acoustical Applications and Sound Evaluation: Based on ARI Standard 885-98, “Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.”

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 practicable. 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. Wall-Mounted Supply Registers: Install 6 inches below finished ceiling unless otherwise indicated.
D. 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 23 3713

SECTION 23 3723
AIR INTAKE AND RELIEF HOODS

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 Sections include the following:
   1. Division 08 Section "Louvers and Vents" for ventilator assemblies provided as part of the general construction.
   2. Division 20 Section “Mechanical General Requirements.”
   3. Division 23 Section "Power Ventilators" for roof-mounting exhaust fans.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Intake and relief ventilators shall be capable of withstanding the effects of gravity loads, wind loads, and thermal movements without permanent deformation of components, noise or metal fatigue, or permanent damage to fasteners and anchors.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Shop Drawings: For intake and relief ventilators. Include plans, elevations, sections, details, and ventilator attachments to curbs and curb attachments to roof structure.

B. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members to which roof curbs and ventilators will be attached.
   2. Sizes and locations of roof openings.

C. Samples for Verification: For each type of exposed finish required for intake and relief ventilators.

D. Welding certificates.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain ventilators through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
B. Product Options: Drawings indicate size, profiles, and dimensional requirements of intake and relief ventilators and are based on the specific equipment 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.
C. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.2, "Structural Welding Code--Aluminum."
   2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.5 COORDINATION

A. Coordinate installation of roof curbs and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.
D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use Phillips flat, hex-head or Phillips pan-head screws for exposed fasteners, unless otherwise indicated.
E. Post-Installed 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.
F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 FABRICATION, GENERAL

A. Factory or shop fabricate intake and relief ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
D. Fabricate supports, anchorages, and accessories required for complete assembly.
E. Perform shop welding by AWS-certified procedures and personnel.

2.4 LOUVER PENTHOUSES

A. Manufacturers:
   1. Acme Engineering & Mfg. Corp.
   2. Greenheck; WRH/WRI.
   3. Loren Cook Company.
   4. Penn Ventilation.
B. Construction: All-welded assembly with stormproof louvers, mitered corners, and glass-fiber lined aluminum sheet roof.
C. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.080 inch for blades.
   1. Air Performance: Not more than 0.10-inch wg static pressure drop at 700-fpm free-area velocity.
   2. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
   3. Exterior Corners: Prefabricated corner units with mitered and welded blades or mitered blades with concealed close-fitting splices and with mullions at corners.
D. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire or flattened, expanded aluminum, 3/4 by 0.050 inch thick.

2.5 GRAVITY INTAKE AND RELIEF HOODS (RECTANGULAR)

A. Manufacturers:
   1. Acme Engineering & Mfg. Corp.
   2. Greenheck; Fabra-Hood.
   3. Loren Cook Company.
   4. Moffitt Corporation, Inc.
   5. Penn Ventilation.
B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 5-6 and 5-7.
C. Materials: Galvanized-steel sheet, minimum 0.064-inch- thick base and 0.040-inch-thick hood suitably reinforced.
D. Bird Screening: Galvanized-steel, 1/2-inch- square mesh, 0.041-inch wire.
E. Galvanized-Steel Sheet Finish:
   1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

2.6 ACCESSORIES

A. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inchchemically treated wood nailer. Size as required to suit roof opening and hood base.
   1. Manufacturers: Roof curbs shall be provided by the hood manufacturer, or one of the following:
      a. Creative Metals.
      b. Pate.
      c. Roof Products & Systems.
      d. ThyCurb.
      e. Any of the listed hood manufacturers.
   2. Configuration: Self-flashing without a cant strip, with mounting flange, and suitable for flat roofs with tapered insulation.
   3. Height: Curb shall extend a minimum 18 inches above top surface of roof insulation.
   4. Metal Liner: Galvanized steel.

B. 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 chemically treated wood nailer. Size as required to suit roof opening and hood base.
   1. Manufacturers: Roof curbs shall be provided by the hood manufacturer, or one of the following:
      a. Creative Metals.
      b. Pate.
      c. Roof Products & Systems.
      d. ThyCurb.
      e. Any of the listed hood manufacturers.
   2. Configuration: Built-in raised cant with step dimension matching insulation thickness, with mounting flange, and suitable for sloped roofs with uniform insulation thickness.
   3. Height: Curb shall extend a minimum 18 inches above top surface of roof insulation.
   4. Pitch Mounting: Manufacture curb for roof slope, top of curb shall be level.
   5. Metal Liner: Galvanized steel.
C. Motorized Backdraft Damper: Refer to DAMPERS – AUTOMATED in Division 23 Section “Temperature Controls.”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install intake and relief hoods level, plumb, and at indicated alignment with adjacent work.
B. Secure intake and relief hoods to roof curbs with cadmium-plated hardware. Use concealed anchorages where possible. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
C. Install intake and relief hoods with clearances for service and maintenance.
D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section "Joint Sealants" for sealants applied during installation.
F. Label intake and relief hoods according to requirements specified in Division 20 Section "Mechanical Identification."
G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
H. 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.

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.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 23 3723

SECTION 23 4100
PARTICULATE AIR FILTRATION

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 Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Materials and Methods.”

1.2 DEFINITIONS

A. DOP: Dioctyl phthalate or bis-(2-ethylhexyl) phthalate.

B. HEPA: High-efficiency particulate air.

C. MERV: Minimum efficiency reporting value.

D. ULPA: Ultra low penetration air.

1.3 SUBMITTALS

A. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
   1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.

C. Operation and Maintenance Data: For each type of filter and rack to include in operation and maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Comply with AHRI 850.

C. Comply with ASHRAE 52.1 and ASHRAE 52.2 for methods of testing and rating air-filter units.
D. Comply with NFPA 70 for installing electrical components.
E. Comply with NFPA 90A and NFPA 90B.

1.5 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. Provide one complete set of filters for each filter bank.

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 DISPOSABLE, EXTENDED AREA PANEL FILTERS (PRE-FILTER)

A. Manufacturers:
   1. Eco Air; C35II.
   2. Filtration Group; Series 400.
   3. Flanders Corporation.
   4. Camfil Farr; 30/30.
   5. AAF International; Amair300X.
B. Media: Pleated, non-woven cotton/polyester blend, bonded to galvanized expanded metal or welded wire grid.
   1. Media pack shall be enclosed in a heavy duty, moisture resistant beverage board frame with support members on both upstream and downstream sides.
   2. Filters shall contain not less than 5.5 square feet of media per square foot of filter face area.
   3. UL Listed, Class II as to flammability.
C. Rating (unless otherwise indicated on drawings) MERV 7 in accordance with ASHRAE 52.2 (30 percent dust spot in accordance with ASHRAE 52.1), 592 fpm face velocity, 0.30-inch wg maximum initial resistance, 1.0-inch wg maximum recommended final resistance.

2.3 HIGH CAPACITY EXTENDED SURFACE (CARTRIDGE) FILTERS

A. Manufacturers:
   1. Eco Air.
   2. Filtration Group.
   3. Flanders Corporation.
   4. Camfil Farr; Riga-Flo.
   5. AAF International.
B. Media: Ultra fine synthetic media, (fiberglass media is not acceptable) deep pleated, totally rigid and totally disposable type.
   1. Each filter shall consist of high efficiency media bonded to a galvanized expanded metal or welded wire grid, contour stabilizers, diagonal support bracing, and galvanized metal enclosing frame.
   2. Each filter shall have foam gasketing on the vertical sides of the header.
   3. Capacity, Efficiency and Nominal Size: As indicated on the drawings.
   4. UL Listed, Class II as to flammability.
C. Ratings:

1. AHU's: MERV 14 in accordance with ASHRAE 52.2 (90-95 percent dust spot in accordance with ASHRAE 52.1),
2. Maximum Recommended Final Resistance: 1.5-inches wg.

2.4 FILTER GAGES

A. Manufacturer:
   1. Dwyer Instruments, Inc.; Magnehelic.
B. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
   1. Diameter: 4-1/2 inches.
   2. Range: 0- to 3.0-inch wg.
C. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install filter frames according to manufacturer's written instructions.
B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
C. Install filters in position to prevent passage of unfiltered air.
D. Install filter gage for each filter bank.
E. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position.
F. Coordinate filter installations with duct and air-handling unit installations.
G. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components, filter and filter-frame installation, and electrical wiring. Report results in writing.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 4100

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SECTION 23 5700
HYDRONIC AND STEAM HEAT EXCHANGERS

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 Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 23 Section "Hydronic Piping.”
   4. Division 23 Section "Steam and Condensate Piping.”

1.2 PERFORMANCE REQUIREMENTS

A. Pressure and Temperature Ratings: Not less than, and as required for system pressures and temperatures as specified in Division 23 Section “Hydronic Piping” and Division 23 Section “Steam and Condensate Piping.”

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, 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. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Operation and Maintenance Data: For heat exchangers to include in operation and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchangers and are based on the specific equipment indicated. Refer to Division 1 Section "Product Requirements."
B. AHRI Compliance: Plate and frame heat exchangers shall carry the AHRI LLHE certification based on AHRI Standard 400.
C. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
D. Registration: Fabricate and label shell-and-tube heat exchangers to comply with the Tubular Exchanger Manufacturers Association's standards.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace all components of heat exchanger that fail in materials or workmanship within 60 months from date of project acceptance. Warranty shall include all parts, labor, travel time and expenses.
B. Contractor shall troubleshoot issues within 24 hours of notification by the Owner.
C. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

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 SHELL-AND-TUBE HEAT EXCHANGERS

A. Manufacturers:
    1. Armstrong Pumps, Inc.
    2. Bell & Gossett; Xylem Inc.
    3. Taco, Inc.
B. Configuration: U-tube with removable bundle.
C. Shell Materials: Steel.
D. Head:
    1. Materials: Cast iron.
    2. Flanged and bolted to shell.
E. Tube:
    1. Seamless copper tubes.
    2. Tube diameter is determined by manufacturer based on service.
F. Tubesheet Materials: Steel tubesheets.
G. Baffles: Steel.
H. Piping Connections:
    1. Shell: Threaded inlet and Flanged inlet and outlet fluid connections, threaded drain, and vent connections.
    2. Head: Threaded or Flanged inlet and outlet fluid connections.
I. Support Saddles:
    1. Fabricated of material similar to shell.

2. Foot mount with provision for anchoring to support.

J. Capacity and Characteristics: Refer to schedule on Drawings.

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.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HEAT-EXCHANGER INSTALLATION

A. Install shell-and-tube heat exchangers on saddle supports.

B. Install shell-and-tube heat exchangers at an elevation that allows condensate drainage by gravity to condensate return piping.

C. Install plate and frame heat exchangers on concrete bases. Concrete base is specified in Division 20 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 03.

D. Concrete Bases: Anchor heat exchanger to concrete base.
   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.
   5. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.

C. Install shutoff valves at heat-exchanger inlet and outlet connections.

D. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

E. Install vacuum breaker at heat-exchanger steam inlet connection.

F. Install hose end valve to drain shell.

3.4 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION 23 5700

SECTION 23 7413
MODULAR AND SEMI-CUSTOM 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air handling equipment.

1.2 SUMMARY

A. This Section includes indoor central-station air-handling units with the following components and accessories as scheduled on the Drawings:
   1. Chilled water cooling coils.

2. Hot water heating coils.
3. Steam heating coils.
4. Air blenders.
5. Supply fan.
6. Economizer outdoor- and return-air damper section.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.4 DEFINITIONS

A. DDC: Direct-digital controls.

1.5 PERFORMANCE REQUIREMENTS

A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 125 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/240 where "L" is the unsupported span length within completed casings.

1.6 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each air handling unit, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

1.7 INFORMATIONAL SUBMITTALS

A. 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.
B. Coordination Drawings: 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. Structural members to which air handling units will be attached.

1.8 CLOSEOUT SUBMITTALS

A. Field quality control test reports.
B. Operation and Maintenance Data: For air handling units to include in operation and maintenance manuals.

1.9 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of central station air-handling units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
B. AHRI Certification: Indoor air-handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.
C. AHRI Compliance:
   1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for air handling units.
   2. Comply with AHRI 270 for testing and rating sound performance for outdoor units.
D. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigeration system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   3. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.

E. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
F. UL Compliance: Comply with UL 1995.
G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

1.10 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.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace all components of the exhaust systems that fail in materials or workmanship within 60 months from date of project acceptance. Warranty shall include all parts, labor, travel time and expenses.
B. Contractor shall troubleshoot issues within 24 hours of notification by the Owner.
C. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

1.12 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. Fan Belts: One set for each belt-driven fan.
   2. Filters: One set of filters for each unit.
   3. Gaskets: One set for each access door.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AAON, Inc.
   2. Buffalo Air Handling; Model J and Outdoor Model J.
   3. Carrier; Div. of United Technologies Corp.; 39 Series.
   4. Daikin Applied; a member of Daikin Industries, Ltd.
   5. JCI/YORK International Corporation.
   6. Nortek Air Solutions; Ventrol, Venmar, and Temtrol Divisions.
   7. Trane; a Trane technologies Brand; Performance Climate Changer.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed. Casing panels shall be solid double-wall construction of pre-painted galvanized steel inner and outer panels and foam insulation. Casing deflection shall not exceed a 1 to 200 ratio when subject to an internal pressure of plus or minus 5-inch wg and shall exhibit no permanent deformation at plus or minus 9-inch wg.
B. Exterior Casing Material: Galvanized steel, knockouts with grommet seals for electrical and piping connections, and lifting lugs.

C. Inner Casing Fabrication Requirements:
   1. Fan sections shall have acoustic interior sheet uniformly perforated with 1/16 or 3/32 inch holes to produce approximately 20 percent open area.
      a. A Mylar or Tedlar lining shall be installed between the insulation and interior sheet.
   2. Floor Plate: Galvanized steel, 0.1382 inch thick.
D. Access Requirements: Removable panels or hinged access doors with neoprene gaskets for inspection and access to internal components.
E. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   1. Materials: Foam panels, ASTM C 1071.
   2. Thickness: 2 inches.
   3. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
   4. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
   5. Location and Application: Encased between outside and inside casing.
F. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.
   1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
   2. Drain Connections: Threaded coupling or nipple.
G. Casing Finish:
   1. External surface of unit casing prepared and coated with a minimum 1.5 mil enamel finish or equal.
   2. Manufacturer's standard color.

2.3 FANS

A. Plenum/Plug Fans:
   1. General: Select fans to avoid instability in service and compute outlet areas to outlet velocities in accordance with AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency.
   2. Description: AMCA certified, factory-fabricated, -assembled, -tested, and -finished, unhoused, belt-driven centrifugal plenum/plug fans consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
   3. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
   4. Accessories:
      a. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
      b. Belt guard.
      c. Direct Drive Plenum Fans:
         1) Variable frequency drives.
         2) Motor protection box for motor current protection with a single VFD driving multiple motors.
         3) Airflow measuring piezo ring.
         4) Piezo ring transducer.
         5) Motor shaft grounding ring.
         6) Inlet guard.
         7) Blank off plate.
         8) Backdraft Dampers
   5. Fan Construction:
      a. Wheel Material: Steel. Metal thickness not less than the minimum specified by AMCA for the class of service.

b. Vibration Isolators: Spring isolators having a static deflection of 1 inch.
c. Refer to schedules on Drawings for additional requirements.

B. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

2.4 COILS

A. Water Coils:
1. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
2. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.
3. Source Quality Control: Factory tested to 300 psig.
4. Tubes: ASTM B 743 copper, minimum 0.024 inch.
5. Fins: Aluminum, minimum 0.010 inch thick.
6. Headers: Cast iron with cleaning plugs, and drain and air vent tappings or seamless copper tube with brazed joints, prime coated.
7. Frames, Chilled Water Coils: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick.

B. Steam Coils:
1. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
2. Minimum Working-Pressure/Temperature Ratings: 125 psig, 400 deg F.
3. Source Quality Control: Factory tested to 400 psig.
4. Tubes: ASTM B 743 copper, minimum 0.031 inch wall thickness, minimum 0.625 inch diameter for distributing tubes, and minimum 1.0 inch diameter for condensing tubes.
5. Fins: Aluminum, minimum 0.010 inch thick.
6. Headers: Cast iron with cleaning plugs, and drain and air vent tappings or seamless copper tube with brazed joints, prime coated.
7. Tube Type: Single or distributing as indicated.
8. Frames: Galvanized-steel channel frame, minimum 0.0625 inch thick.

2.5 AIR BLENDERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Blender Products, Inc.

B. Performance Requirements: The blender shall be capable of mixing two airstreams to within a plus or minus 6 deg F tolerance of the theoretical mixed air temperature when mixing 50 percent outside air with 50 percent return air at 60 deg F inlet temperature differential, and to within a plus or minus 4.5 deg F tolerance when mixing 30 percent outside air with 70 percent return air at 60 deg F inlet temperature differential. The blender's performance range shall be from 600 FPM through 2500 FPM (blender velocity) with no loss in mixing performance. The blender shall provide a uniform velocity profile at downstream components such as filters, coils, etc.

C. Size, Pressure Drop and Capacity: As indicated on the Drawings.

D. Unit Casing: Constructed to meet the applicable requirements for central-station air handling units. Casing size shall exactly match the sizes of the upstream and downstream air handling unit modules.

E. Material: Minimum 0.080-inch thick aluminum.

F. Blenders shall be installed in accordance with the manufacturer's instructions, including but not limited to the provision for required upstream and downstream mixing distances.

2.6 FILTER SECTION

A. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side.

B. Filters: Size, type, and rating as scheduled on the Drawings. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Air Filter Manufacturers:
      a. AAF International.
      b. Camfil Farr Co.
      c. ECO Air.
      d. Filtration Group, Inc.
      e. Flanders Filters, Inc.

2.7 ELECTRICAL REQUIREMENTS

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 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 air handling unit.
   1. House in NEMA 250, Type 3R enclosure.
   2. Wiring shall be numbered and color-coded to match wiring diagram.
   3. Install wiring outside of an enclosure in a metal raceway.
   4. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
   5. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than 42,000 A.
   6. Minimum short circuit design shall be in accordance with Electrical Contractor provided short circuit analysis.
   7. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
      a. NEMA KS 1, heavy-duty, nonfusible switch.

2.8 CONTROLS

A. Control equipment is specified in Division 23 Section "Temperature Controls," and sequence of operation is indicated on the Drawings.

2.9 ACCESSORIES

A. Service Outlets: Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Outlet shall remain energized even if the unit main disconnect is open.
B. Lighting: Vapor-proof, marine-type, 100-watt service lights in segments indicated on Drawings. Lights shall be wired to single on/off toggle switch which brings all lights on at once. Lights shall be operable even if the main disconnect is open.
C. Filter Differential Pressure Switch: With sensor tubing on either side of filter. Set for final filter pressure loss.

2.10 CAPACITIES AND CHARACTERISTICS

A. Refer to Schedule on Drawings.

2.11 SOURCE QUALITY CONTROL

A. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

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 air handling units.
B. Examine roughing-in for air handling units to verify actual locations of piping and duct connections before equipment installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION (INDOOR UNITS)

A. Concrete Bases: Install floor mounting units on 4-inch- high concrete bases. See Division 20 Section "Basic Mechanical Materials and Methods" for concrete base materials and fabrication requirements.
B. Hoist, transport, and rig units or their shipping sections into position following procedures recommended by manufacturer.
C. Install indoor air-handling units with the following vibration -control devices. Vibration -control devices are specified in Division 20 Section "Mechanical Vibration Controls."
    1. Units with Internally Isolated Fans:
        a. Floor-Mounted Units: Support on concrete bases using neoprene pads. Secure units to anchor bolts installed in concrete bases.
    2. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and spring hangers.
D. Arrange installation of units to provide access space around indoor air-handling units for service and maintenance.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections.
B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
C. Install piping adjacent to air handling units to allow service and maintenance.
D. Duct installation requirements are specified in other Division 23 Sections. The following are specific connection requirements:
    1. Install ducts to termination at top of roof curb.
    2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
    3. Connect supply ducts to air handling units with flexible duct connectors specified in Division 23 Section "Duct Accessories."
    4. Install return-air duct continuously through roof structure.

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. Report results in writing.
    1. After installing air handling units and after electrical circuitry has been energized, test units for compliance with requirements.
    2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
    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.
B. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Inspect for visible damage to unit casing.
   2. Inspect for visible damage to furnace combustion chamber.
   3. Inspect for visible damage to coils and fans.
   4. Inspect internal insulation.
   5. Verify that labels are clearly visible.
   6. Verify that clearances have been provided for servicing.
   7. Verify that controls are connected and operable.
   8. Verify that filters are installed.
   9. Clean furnace flue and inspect for construction debris.
   10. Remove packing from vibration isolators.
   11. Inspect operation of barometric relief dampers.
   12. Verify lubrication on fan and motor bearings.
   13. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   14. Adjust fan belts to proper alignment and tension.
   15. Start unit according to manufacturer's written instructions.
       a. Complete startup sheets and attach copy with Contractor's startup report.
   16. Inspect and record performance of interlocks and protective devices; verify sequences.
   17. Operate unit for an initial period as recommended or required by manufacturer.
   18. Calibrate thermostats.
   19. Adjust and inspect high-temperature limits.
   20. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
   21. Cooling System: Measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
       a. Coil leaving-air, dry- and wet-bulb temperatures.
       b. Coil entering-air, dry- and wet-bulb temperatures.
       c. Outdoor-air, dry-bulb temperature.
       d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
   22. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
   23. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
       a. Supply-air volume.
       b. Return-air volume.
       c. Relief-air volume.
       d. Outdoor-air intake volume.
   24. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
       a. High-temperature limit on gas-fired heat exchanger.
       b. Low-temperature safety operation.
       c. Filter high-pressure differential alarm.
       d. Economizer to minimum outdoor-air changeover.
       e. Relief-air fan operation.
       f. Smoke and firestat alarms.
   25. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND 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 site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing air handling units and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air handling units.

END OF SECTION 23 7413

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SECTION 23 8126
SPLIT-SYSTEM AIR-CONDITIONING 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes ductless split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components.

B. Products supplied but not installed under this Section:
   1. Roof curbs and equipment rails.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For split-system air-conditioning units to include in operation and maintenance manuals.

1.6 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 an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
C. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
E. Seasonal Energy-Efficiency Ratio (SEER): Minimum 13.

1.7 COORDINATION

A. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division 07 Section “Roof Accessories.” Pipe Roof Penetration Enclosures are specified in Division 20 Section “Basic Mechanical Materials and Methods.”

1.8 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 for compressor and refrigerant circuit, and one year from date of substantial completion for other components.

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. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Single-Zone Split-System Air-Conditioning Units:
      a. Airedale North America, Inc.
      b. Carrier Corp.; United Technologies Corporation.
      c. Daikin Applied; a member of Daikin Industries, Ltd.; Daikin AC.
      d. Johnson Controls-Hitachi.
      e. LG Electronics, HVAC Division.
      f. Mitsubishi Electric & Electronics America, Inc.; HVAC Advanced Products Division.
      g. Panasonic Corporation of North America.
      h. Samsung Electronics.
   2. Roof Curbs and Equipment Rails:
      a. Pate Company (The).
      b. Roof Products and Systems Corp.
      c. ThyCurb; a division of THYBAR Corporation.

2.2 SINGLE-ZONE DUCTLESS SPLIT SYSTEM AIR CONDITIONER

A. Complete packaged air conditioning unit factory fabricated and tested.

B. Indoor Evaporator Section: Complete with fan section, motor, washable filter, condensate drain pan, field installed condensate pump where indicated, and direct expansion evaporator section.
C. Air Cooled Condensing Section: Completely factory piped for single point connection of refrigerant lines. Condensing unit with propeller fan shall be matched to evaporator section to provide cooling capacity as scheduled on drawings.
D. Controls: Unit furnished with factory installed microprocessor controls. Provide wireless remote or unit mounted control or wall thermostat, which shall provide selection of all functions and control of room temperature set points. Furnish and install one mounting bracket for each wireless remote control.
E. Provide complete refrigerant piping circuit (including all piping specialties) sized in accordance with manufacturer's requirements to interconnect evaporator and condenser sections.
F. Wall-Mounting, Evaporator-Fan Components:
    1. Cabinet: With removable panels for servicing, and discharge drain pans with drain connection.
    2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
    3. Fan: Direct drive, centrifugal fan.
    4. Fan Motors: Comply with requirements in Division 20 Section "Motors."
        a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
    5. Filters: Disposable, with ASHRAE 52.2 MERV rating of 6 or higher.
G. Ceiling-Mounting, Evaporator-Fan Components:
    1. Cabinet: Enameled steel chassis with removable panels on front and ends, and discharge drain pans with drain connection.
    2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
    3. Fan: Direct drive, centrifugal fan, with outside air intake, and integral factory or field installed condensate pump.
    4. Fan Motors: Comply with requirements in Division 20 Section "Motors."
        a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
    5. Filters Disposable, with ASHRAE 52.2 MERV rating of 6 or higher.
H. Air-Cooled, Compressor-Condenser Components:
    1. Casing: Steel, finished with baked enamel, 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.
    2. 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.
        a. Compressor Type: Reciprocating or Scroll.
        b. Include refrigerant charge.
        c. Refrigerant: R-410A.
    3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.
    4. Fan: Aluminum-propeller type, directly connected to motor.
    5. Motor: Permanently lubricated, with integral thermal-overload protection.
    6. Low Ambient Kit: Permits operation down to 0 deg F.]
I. Control equipment is specified in Division 23 Section "Temperature Controls," and sequence of operation is indicated on the Drawings.
J. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
    1. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.

2. Fan-speed selection, including auto setting.

K. Automatic-reset timer to prevent rapid/short cycling of compressor.

2.3 ACCESSORIES

A. Roof Curbs and Equipment Rails:
   1. Minimum 18 gage welded galvanized steel construction.
   2. Integral base flange or plate.
   3. Factory installed insect and decay resistant wood nailer.
   4. Top of curb or equipment support shall be level and extend a minimum of 8 inches above the top of the roof insulation.

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. Deliver roof curbs and equipment support to site for installation under Division 07. Install roof-mounting compressor-condenser components on equipment supports specified. Anchor units to supports with removable, cadmium-plated fasteners. Install wind baffle according to manufacturer’s installation instructions.

D. Install and connect refrigerant tubing to components. Install tubing to allow access to unit. Evacuate and charge with refrigerant in accordance with manufacturers instructions.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections.

B. Install piping adjacent to unit to allow service and maintenance.

C. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

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 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 8126

SECTION 23 8216
HEATING AND COOLING COILS

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 Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 23 Sections for coils that are integral to air-handling units.

1.2 SUMMARY

A. This Section includes duct-mounted heating and cooling coils, and heating and cooling coils that are an integral part of air-handling units.

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 coil. Include rated capacity and pressure drop for each coil.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

C. Field quality-control test reports.

D. 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 an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigeration system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of coils that fail in materials or workmanship within 60 months from date of project acceptance. Contractor shall troubleshoot issues within 24 hours of notification by the Owner. Warranty shall include all parts, labor, travel time and expenses.

B. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

PART 2 - PRODUCTS

2.1 WATER COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerofin Corporation.
   2. Luvata/Heatcraft Commercial/Industrial Products.
   3. Daikin.
   4. Trane.

B. Performance Ratings: Tested and rated according to AHRI 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 0.024 inch wall thickness, and minimum 0.50 inch diameter.

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, Hot Water Coils: Galvanized-steel channel frame, minimum 0.0625 inch thick for slip-in mounting.

I. Frames, Chilled Water Coils: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for slip-in mounting.

2.2 VERTICAL-TUBE INTEGRAL FACE-AND-BYPASS COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerofin Corporation.
   2. L.J. Wing; a Mestek Company.

B. Source Quality Control: Finned heating elements factory tested at 200 psig steam and 500 psig hydrostatic pressure.

C. Description: Built-in series of finned heating elements and by-passes with interlocked dampers modulated by damper motor.
   1. Elements fabricated of seamless straight, vertical copper tubes with rectangular aluminum fins.
   2. Each tube individually secured to supply and return headers by brazed joint with provisions for individual tube expansion and contraction.

D. Damper Motor: Meet requirements of Division 23 Section “Temperature Controls.”

E. Dampers: Arranged to completely enclose and isolate heating coil passes when temperature rise is not required. Constructed of 16 gage cold-rolled steel with baked enamel finish.

F. Casing: Constructed of 14 gage galvanized steel, with rigid framework, completely painted.

G. Maintain constant discharge temperature regardless of variations in entering air temperature with full steam pressure.
H. Proportioning of air shall be such that temperature at any point in a plane parallel to face of coil three feet downstream from leaving side shall not vary more than 5 deg F from average discharge air stream temperature.
I. Volume of air passing through coil shall not vary more than plus or minus 5 percent regardless of internal damper position.

2.3 STEAM COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerofin Corporation.
   2. Carrier; a United Technologies Company.
   3. Daikin Applied; a member of Daikin Industries, Ltd.
   4. Luvata/Heatcraft Commercial/Industrial Products.
   5. Trane Inc.; a Division of Ingersoll Rand.
B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
C. Minimum Working-Pressure/Temperature Ratings: 125 psig, 400 deg F.
D. Source Quality Control: Factory tested to 400 psig.
E. Tubes: ASTM B 743 copper, minimum 0.031 inch wall thickness, minimum 0.625 inch diameter for distributing tubes, and minimum 1.0 inch diameter for condensing tubes.
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. Tube Type: Distributing.
I. Frames: Galvanized-steel channel frame, minimum 0.0625 inch thick for slip-in mounting.

2.4 DRAIN PANS

A. Description: For cooling coils, IAQ compliant formed to slope from all directions to the drain connection as required by ASHRAE 62.
B. Construction: Minimum 22 gage, Type 304 stainless steel with welded joints, positively sloped a minimum of 1/8 inch per foot, with threaded drain connection at lowest point of pan. Intermediate pans piped to the primary drain pan are required for all stacked cooling coils.
C. Provide intermediate coils with 3 inch deep pans for each tiered coil bank. Top pan shall extend 6 inches beyond face of coil and bottom pan shall extend not less than 12 inches beyond face of coil. Where more than two panes are used, pan extension shall be proportional.
D. Supports: Same material as pans.
E. Pipe pan drain to floor drain. A deep seal trap shall be installed on the drain pipe from the pans.

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. Install minimum 22 gage, Type 304 stainless-steel drain pan under each cooling coil.
   1. Construct drain pans with connection for drain; insulated.
   2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
   3. Extend drain pan upstream and downstream from coil face.
   4. Extend drain pan under coil headers and exposed supply piping.
D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.
E. Straighten bent fins on air coils.
F. 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 20 and 23 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 23 Section "Temperature Controls," and other piping specialties are specified in Division 23 Section "Hydronic Piping."

END OF SECTION 23 8216

SECTION 23 8219
FAN-COIL 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 DEFINITIONS

A. BAS: Building automation system.

B. IAQ: Indoor air quality.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

B. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Ceiling suspension components.
   2. Structural members to which fan-coil units will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.

5. Items penetrating finished ceiling, including the following:
    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
6. Perimeter moldings for exposed or partially exposed cabinets.

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.
B. Operation and Maintenance Data: For fan-coil units to include in operation and maintenance manuals.
C. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

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. Fan-Coil-Unit Filters: Furnish spare filter for each filter installed.
    2. Fan Belts: Furnish one set of spare fan belts for each unit installed.

1.9 WARRANTY

A. All warranty related issues must be addressed and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.

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 BLOWER COIL UNITS

A. Manufacturers:
   1. Carrier; a United Technologies Company.
   2. Daikin Applied; a member of Daikin Industries, Ltd.
   3. Trane Inc.; a Division of Ingersoll Rand.
B. Description: Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.
C. Coil Section Insulation: Minimum 1/2-inch thick dual-density coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
   1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
D. Drain Pans: Stainless steel. Include factory-installed float switch to detect high condensate water level and disable fan operation.
E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.
F. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.
H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, 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.
I. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multi-speed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
J. Motors: Comply with requirements in Division 20 Section "Motors."
K. Control devices and operational sequence are specified in Division 23 Sections "Temperature Controls" and indicated on "Sequence of Operation" on the Drawings.
L. Electrical Connection: Factory wire motors and controls for a single electrical connection.
M. Capacities and Characteristics: Refer to schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units 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 fan-coil-unit installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units level and plumb.
B. Install fan-coil units to comply with NFPA 90A.
C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 20 Section "Mechanical Vibration Controls."
D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.
E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Install piping adjacent to machine to allow service and maintenance.
   2. Connect condensate drain to indirect waste.
      a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Connect refrigerant tubing to components. Install tubing to allow access to unit. Evacuate and charge with refrigerant in accordance with manufacturer’s instructions.

C. Water Piping: Unless otherwise indicated:
   1. Install union or flange and isolation valve on supply-water connection.
   2. Install union or flange and calibrated balancing valve or PICCV as indicated on the Drawings on return-water connection.
   3. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

D. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

F. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 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. Report results in writing.

B. 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. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

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.

END OF SECTION 23 8219

SECTION 23 8229
HOT WATER RADIANT HEATING 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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUBMITTALS

A. Product Data: Include rated capacities, specialties, and accessories for each product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and suspension and attachment. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which heaters and suspension systems will be attached.
   3. Size and location of initial access modules for acoustical tile.
   4. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
   5. Perimeter moldings.

1.3 COORDINATION

A. Coordinate layout and installation of radiant heaters and panels and suspension system components 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 HYDRONIC HEATING PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aero Tech Manufacturing; A subsidiary of Toromont Industries.
   2. AIRTEX Radiant Systems; a division of Engineered Air Ltd.
   3. Rittling; a Zehnder Group Company.
   4. Steel Ceilings, Inc.; Airtite Radiant Ceiling Systems.
   5. Sterling Hydronics; a Mestek Company.
   6. Sun-El Corporation.
   7. Twa Panel Systems Inc.

B. Description: Linear metal panel with serpentine water piping, suitable for installation flush with T-bar ceiling grid.
   1. Panels: Fluted, extruded aluminum sheet.
   2. Backing Insulation: Minimum 1-inch- thick, mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB with factory-applied jacket.
   3. Piping Inlet and Outlet: NPS 1/2.
   4. Exposed-Side Panel Finish: Baked-enamel finish in manufacturer's standard paint color as selected by Architect.
   5. Factory Piping: ASTM B 88, Type L copper tube with ASME B16.22 wrought-copper fittings and brazed joints. Piping shall be mechanically bonded to panel.
   6. Accessories:
      a. 5-inch male bullnose panel.
      b. 5-inch female bullnose panel.
      c. 4-inch male corner panel.
      d. 4-inch female corner panel.
      e. Inside corner panel.
      f. 1/2-inch filler panel.

C. Capacities and Characteristics: Refer to Schedules on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive radiant heating and cooling 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 radiant heating and cooling unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install radiant heating units level and plumb.

B. The installation of the radiant panel ceiling and matching non-radiant (inactive) panels shall be made by a single Radiant Ceiling Sub-Contractor experienced in this work. The subcontractor shall provide labor, materials, equipment, and supervision for a complete and operational system. Sub-Contractor shall submit certification of having a minimum of two (2) years previous experience in radiant ceiling installations.
   1. Contractor shall provide all necessary wall channels, angles and required support for radiant panel. Contractor shall provide tee sections between adjacent panels and at panel ends. Contractor shall verify ceiling openings are large enough to accommodate thermal expansion and contraction of ceiling panels. The ceiling contractor shall provide and install the tee between the acoustical ceiling and the radiant panel along the length of the panel.

C. Radiant ceiling panel suspension shall be independent of the ceiling system.

D. Hangers shall be installed as recommended by the manufacturer.
E. Contractor shall integrate and coordinate radiant ceiling panel installation with ceiling grid installation (by others).
F. The Radiant Ceiling Sub-Contractor shall cooperate with other trades working in the ceiling to achieve a neat, well coordinated, and properly sequenced overall installation.
G. Work of Radiant Ceiling Sub-contractor shall terminate within three feet of the supply and return point of each panel circuit.
H. The Radiant Ceiling Sub-Contractor shall furnish and install all necessary piping and bends required for the interconnection of the panel sections. The panel interconnecting pipe and bends shall be furnished by the panel manufacturer and shall provide for necessary expansion and contraction as recommended by the manufacturer.
I. All installation of linear panels, where made with mitered joints, shall be made so that the fluting on the abutting panel is aligned.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
C. Install piping adjacent to unit to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field tests and inspections and prepare test reports:
   1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and units.
B. Remove and replace malfunctioning units and retest as specified above.
C. After installing panels, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain radiant heaters and panels. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 23 8229

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SECTION 23 8233
CONVECTION HEATING UNITS

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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. 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, corner pieces, access doors, and other accessories.

1.4 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For convection heating 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, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 HOT-WATER OR STEAM FINNED-TUBE RADIATORS (Pedestal Mounted)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Rittling; A Zehnder Group Company.
   2. Sterling Hydronics; a Mestek Company.
   3. Trane; a Trane Technologies Brand.
   4. Vulcan Radiator; a Mestek Company.
B. Performance Ratings: Rate finned-tube radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports, ends suitable for solder fittings.
D. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.
E. Front Panel: Minimum **0.0528-inch** thick steel.
F. Floor-Mounting Pedestals: Conceal insulated piping at maximum 36-inch spacing. Pedestal-mounting back panel shall be solid panel matching front panel. Provide stainless-steel escutcheon for floor openings at pedestals.
G. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
H. Finish: As indicated in the equipment schedules. In a standard color as selected by Architect.
I. Damper: Knob-operated internal damper at enclosure outlet.
J. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.
K. Enclosure Style: As indicated in the equipment schedules.
L. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

2.2 HOT-WATER OR STEAM FINNED-TUBE RADIATORS (Wall Mounted)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Rittling; A Zehnder Group Company.
   2. Sterling Hydronics; a Mestek Company.
   3. Trane; a Trane Technologies Brand.
   4. Vulcan Radiator; a Mestek Company.
B. Performance Ratings: Rate finned-tube radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports, ends suitable for solder fittings.
D. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.
E. Front Panel: Minimum 0.0528-inch- thick steel.
F. Wall-Mounting Back Panel: Minimum 0.0329-inch- thick steel, full height, with full-length channel support for front panel without exposed fasteners.
G. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
H. Finish: As indicated in the equipment schedules. In a standard color as selected by Architect.

I. Damper: Knob-operated internal damper at enclosure outlet where indicated.
J. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.
K. Enclosure Style As indicated in the equipment schedules.
L. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

2.3 PANEL (FLAT-PIPE STEEL) RADIATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Runtal North America, Inc.; A Zehnder Group Company.
   2. Rittling; A Zehnder Group Company; Panel Radiators.
B. Heating Elements: Steel, welded and formed into flat, square, steel header with minimum thickness of 0.109 inches. Include threaded piping and air vent connections.
   1. High: Working Pressure 128 psig maximum. Test Pressure 184 psig maximum.
C. Mounting: Wall brackets on maximum spacing of 36 inches.
D. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
E. Accessories:
   1. Steel piping covers finished to match radiator finish.
   2. Flexible Expansion Compensation Hoses: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F.
      a. Minimum Diameter: Equal to connection size.
   3. Integral heavy-gage steel, all-welded top grille.

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 FINNED-TUBE RADIATOR INSTALLATION

A. Install units level and plumb.
B. Install enclosure continuously around corners, using outside and inside corner fittings.
C. Join sections with splice plates and filler pieces to provide continuous enclosure.
D. Install access doors for access to valves.
E. Install enclosure continuously from wall to wall.
F. Terminate enclosures with manufacturer's end caps, except where enclosures are indicated to extend to adjoining walls.
G. Install valves within reach of access door provided in enclosure.
H. Install air-seal gasket between wall and recessing flanges or front cover of fully recessed unit.
I. Install piping within pedestals for freestanding units.

3.3 FLAT-PIPE STEEL RADIATOR INSTALLATION

A. Install units level and plumb.
B. Install expansion compensation hoses.
C. Install piping covers.

3.4 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Hot Water Piping: Unless otherwise indicated:

1. Install union and isolation valve on supply-water connection.
2. Install union and calibrated balancing valve or PICCV as indicated on the Drawings on return-water connection.
3. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

C. Install control valves as required by Division 23 Section "Temperature Controls."
D. Install piping adjacent to convection heating units to allow service and maintenance.

3.5 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 23 8233

SECTION 23 8240
CENTRIFUGAL FAN CABINET 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.
B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes cabinet unit heaters with centrifugal fans and hot-water coils.

1.3 DEFINITIONS

A. BAS: Building automation 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. Location and arrangement of piping valves and specialties.
   4. Location and arrangement of integral controls.
   5. Wiring Diagrams: Power, signal, and control wiring.
C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Suspended ceiling components.
   2. Size and location of initial access modules for acoustical tile.

3. Items penetrating finished ceiling, including the following:
    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
4. Perimeter moldings for exposed or partially exposed cabinets.

D. Operation and Maintenance Data: For cabinet unit heaters to include in 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 spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Hot-Water Cabinet Unit Heaters:
        a. Dunham-Bush, Inc.
        b. Hydro-Air Components Inc.; Rittling.
        c. McQuay International.
        d. Modine Manufacturing Co.
        e. Sterling Radiator; a Mestek Company.
        f. Trane.
        g. Vulcan Radiator; a Mestek Company.

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: 1/2 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, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
    2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch- thick, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
    3. Control Access Door: Key operated.

E. Filters: Washable.

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, high static, 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 20 Section "Motors."
   3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
H. DDC Terminal Controller:
   1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
   2. Unoccupied Period Override: Two hours.
   3. Unit Supply-Air Fan Operations:
      a. Occupied Periods: Fan runs continuously.
      b. Unoccupied Periods: Fan cycles to maintain setback room temperature.
   4. Heating Coil Operations:
      a. Occupied Periods: Open control valve to provide heating if room temperature falls below thermostat set point.
      b. Unoccupied Periods: Start fan and open control valve if room temperature falls below setback temperature.
   5. Controller shall have volatile-memory backup.
I. Electrical Connection: Factory wire motors and controls for a single field connection.
J. Capacities and Characteristics: Refer to Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet 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 cabinet unit heater installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 7 Section "Joint Sealants."
B. Install cabinet unit heaters to comply with NFPA 90A.
C. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Division 20 Section "Mechanical Vibration and Seismic Controls."
D. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 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 cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Duct Accessories."
E. Comply with safety requirements in UL 1995.
F. Ground equipment according to Division 26 Section "Grounding and Bonding."
G. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   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.

3.5 ADJUSTING

A. Adjust initial temperature set points.
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.

END OF SECTION 23 8240

SECTION 23 8241
PROPELLER FAN UNIT HEATERS – HOT WATER

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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes propeller fan unit heaters with hot-water coils.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each unit type and configuration.

B. Operation and Maintenance Data: For propeller unit heaters to include in emergency, 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 NRTL acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hot-Water Unit Heaters:
      a. Dunham-Bush, Inc.
      b. Hydro-Air Components; Rittling.
      c. McQuay International.
      d. Modine Manufacturing Co.
      e. Sterling Radiator, a Mestek Company.
      f. Trane.
      g. Vulcan Radiator, a Mestek Company.

2.2 UNIT HEATERS

A. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

2.3 CASING

A. Cabinet: Removable panels for maintenance access to controls.
B. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
C. Discharge Louver: Four-way adjustable louvers for horizontal units and adjustable pattern diffuser for projection units.

2.4 COILS

A. Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.
B. 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.

2.5 FAN

A. Propeller type, aluminum wheel directly mounted on motor shaft in the fan venturi.

2.6 FAN MOTORS

A. Comply with requirements in Division 20 Section "Motors."
B. Motor Type: Permanently lubricated.

2.7 CONTROLS

A. Field installed by Temperature Control Contractor.

2.8 CAPACITIES AND CHARACTERISTICS

A. Refer to Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller 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 propeller unit-heater installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install propeller unit heaters level and plumb.
B. Install propeller unit heaters to comply with NFPA 90A.
C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Division 20 Section "Hangers and Supports." Vibration hangers are specified in Division 20 Section "Mechanical Vibration Controls."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
C. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of unit heater. Steam specialties are specified in Division 23 Section "Steam and Condensate Piping."
D. Ground equipment according to Division 26 Section "Grounding and Bonding."
E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing and report results in writing:
    1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    2. Test and adjust controls and safeties.
B. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller fan unit heaters. Refer to Division 20 Section "Mechanical General Requirements."

END OF SECTION 23 8241

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SECTION 26 0010
ELECTRICAL GENERAL REQUIREMENTS

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 of this section.

1.2 SUMMARY

A. This Section includes electrical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.3 REFERENCES

A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of

equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. A.N.S.I. - American National Standards Institute
2. A.S.T.M. - American Society for Testing Materials
3. I.C.E.A. - Insulated Cable Engineers Association
4. I.E.E.E. - Institute of Electrical and Electronics Engineers
5. N.E.C. - National Electrical Code
6. N.E.C.A. -National Electrical Contractors Association
7. N.E.M.A. - National Electrical Manufacturer's Association
8. U.L. - Underwriters Laboratories, Inc.
9. N.E.C.A. 1-2000, “Practices for Good Workmanship in Electrical Contracting (ANSI).”

1.4 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical systems as specified in the Division 26 Sections and as indicated on Drawings.
   1. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.
   2. The Contractor understands that the work herein described shall be complete in every detail.

B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of NFPA, NECA, and UL, unless otherwise indicated.
   1. Notify the Architect/Engineer before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.

C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.

D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

F. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner’s Representatives causes interference.

1.5 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for electrical work shall be secured and paid for by the Contractor. All work shall conform to all applicable codes, rules and regulations.

B. Rules of local utility companies shall be complied with. Coordinate with the utility company supplying service to the installation and determine all devices including, but not limited to, all current and potential transformers, meter boxes, C.T. cabinets and meters which will be required and include the cost of all such items and all utilities costs in proposal.

C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed Drawings or diagrams which may be

required by the governing authorities. Where the Drawings and/or Specifications indicate materials or construction in excess of code requirements, the Drawings and/or Specifications shall govern.

1.6 DRAWINGS

A. The Drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions.

C. Deviations from the Drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.7 MATERIAL AND EQUIPMENT MANUFACTURERS

A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of electrical equipment and shall be of the manufacturer's latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, electrical work, and building alterations shall be included in the original Bid. Similar equipment shall be by one manufacturer.

C. Where existing equipment is modified to include new switches, circuit breakers, metering or other components, the new components shall be by the original equipment manufacturer and shall be listed for installation in the existing equipment. Where original equipment manufacturer components are not available, third party aftermarket components shall be listed for the application and submitted to the engineer for approval. Reconditioned or salvaged components shall not be used unless specifically indicated on the drawings.

1.8 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.9 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.
   1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
   2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.

1.10 SHOP DRAWINGS/SUBMITTALS

A. Submit project-specific submittals for review in compliance with Division 1.

B. All shop Drawings shall be submitted in groupings of similar and/or related items per each specification section (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.

C. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

A. Submit for approval shop drawings for electrical systems or equipment indicated in other sections of electrical specs. Where items are referred to by symbolic designation on the Drawings and Specifications, all submittals shall bear the same designation (light fixtures).

1.11 COORDINATION DRAWINGS

A. Submit project specific coordination drawings for review in compliance with Division 1 Specification Sections.

1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 1 Specification Sections.

B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Four (4) copies of all literature shall be furnished for Owner and shall be bound in ring binder form. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.

C. The operating and maintenance instructions shall include a brief, general description for all electrical systems including, but not limited to:
   1. Routine maintenance procedures.
   2. Trouble-shooting procedures.
   3. Contractor's telephone numbers for warranty repair service.
   4. Submittals.
   5. Recommended spare parts lists.
   6. Names and telephone numbers of major material suppliers and subcontractors.

7. System schematic drawings on 8-1/2" x 11" sheets.

1.13 RECORD DRAWINGS

A. Submit record drawings in compliance with Division 1.
B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media which have been neatly marked to represent as-built conditions for all new electrical work. Modifications to original drawings shall be clearly marked with a contrasting color so the marks are readily apparent.
C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request during the course of construction.

1.14 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.
B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.
D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.

1.15 WARRANTY

A. Warranty: Comply with the requirements in Division 1 Specification Sections. Contractor shall warranty that the electrical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents. Contractor shall troubleshoot issues within 24 hours of notification by the Owner. Warranty shall include all parts, labor, travel time and expenses.
B. Contractor shall be responsible for any temporary services including equipment and installation required to maintain operation as a result of any equipment failure or defect during warranty period.
C. All warranty related issues must be addressed, and corrective action must be completed within 72 hours of notification of the associated warrant issue. The contractor will be responsible for all damage resulting from the warranty failure. In the event that the warranty issue has not been completed within 72 hours, the Owner has the right to have an authorized equipment service technician resolve the issue. All costs for these repairs will be back charged to the Contractor holding the warranty for all related costs.
D. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.16 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner's consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.

B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

1.17 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 8 Section "Access Doors and Frames."
D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS (not applicable)

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 raceways and piping systems installed at a required slope.

3.2 DEMOLITION WORK

A. All demolition of existing electrical equipment and materials will be done by this Contractor unless otherwise indicated. Include all items such as, but not limited to, electrical equipment, devices, lighting fixtures, conduit, and wiring called out on the Drawings and as necessary whether such items are actually indicated on the Drawings or not in order to accomplish the installation of the specified new work.
B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.
C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.

D. Where equipment or fixtures are removed, outlets shall be properly blanked off, and conduits capped. After alterations are done, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present electrical work to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.
E. Reroute signal wires, lighting and power wiring as required to maintain service. Where walls and ceilings are to be removed as shown on the Drawings, the conduit is to be cut off by the Electrical Trades so that the abandoned conduit in these walls and ceilings may be removed with the walls and ceilings by the Architectural Trades. All dead-end conduit runs shall be plugged at the remaining line outlet boxes or at the panels.
F. Where new walls and/or floors are installed which interfere with existing outlets, devices, etc., the Electrical Trades shall adjust, extend and reconnect such items as required to maintain continuity of same.
G. All electrical work in altered and unaltered areas shall be run concealed wherever possible. Use of surface raceway or exposed conduits will be permitted only where approved by the Architect/Engineer.
H. Existing lighting shall be reused where indicated on plans. Reused fixtures shall be detergent cleaned, relamped and reconditioned suitable for satisfactory operation and appearance.

3.3 INSTALLATION OF EQUIPMENT

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.
B. Device Location:
   1. Allow for relocation prior to installation of wiring devices and other control devices, for example, receptacles, switches, fire alarm devices, and access control devices, within a 10-foot radius of indicated location without additional cost.

3.4 WORK IN EXISTING BUILDINGS

A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.
B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.
C. Consult with the Owner’s Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.
D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.5 TEMPORARY SERVICES

A. Provide and remove upon completion of the project, in accordance with the general conditions and as described in Division 1, a complete temporary electrical and telephone service during construction.

3.6 DISPOSAL

A. Fluorescent Lamps
   1. Fluorescent lamps are known to contain mercury and are classified as hazardous material. All fluorescent lamps shall be assumed to contain mercury unless tested and confirmed otherwise with a toxicity characteristic leaching procedure (TCLP).
   2. Hazardous materials (fluorescent lamps), shall be sent to a lamp recycling facility. The materials shall be properly packaged with labels that meet the Department of Transportation Regulations and stored in a secure location prior to transportation.
   3. The Contractor shall identify the costs of the lamp disposal process including, but not limited to, the lamp packaging, storage, transportation, disposal, and any profile fees.
   4. At the completion of the project, provide documentation to verify that the lamps have been properly disposed of in accordance with all local, state and federal guidelines.

B. Ballasts
   1. Lighting ballasts manufactured prior to 1979 have been known to contain polychlorinated biphenyls (PCBs). Unless specifically noted on the ballast as containing "No PCBs," the ballast shall be assumed to contain components with PCB materials.
   2. Hazardous materials (ballasts with PCBs), shall be disposed of at a hazardous waste incineration facility, or at a recycling facility in accordance with the Code of Federal Regulations as administered by the EPA in regards to this issue. The ballasts shall be packaged/stored in fifty-five gallon steel drums with labels that meet the Department of Transportation Regulations.
   3. The Contractor shall identify the costs of the ballast disposal process including, but not limited to, the packaging, storage, transportation, disposal, and any profile fees.
   4. Provide at completion of the project documentation (manifests) to verify that the ballasts have properly been disposed of in accordance with all local, state and federal guidelines.

3.7 CHASES AND RECESSES

A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.8 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

A. Refer to General Conditions for requirements.
B. All cutting, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.9 EXCAVATION AND BACKFILLING

A. Provide all excavation, trenching, tunneling, dewatering and backfilling required for the electrical work. Coordinate the work with other excavating and backfilling in the same area.
B. Where conduit is installed less than 2'6" below the surface of pavement, provide concrete encasement, 4" minimum coverage, all around or as shown on the electrical Drawings.
C. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

D. Backfill all excavations inside building, under drives and parking areas with well-tamped granular material. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.
E. Backfill outside building with granular material to a height 12 inches over top of pipe compacted to 95 percent compaction as specified above. Backfill remainder of excavation with unfrozen, excavated material in such a way to prevent settling.

3.10 EQUIPMENT CONNECTIONS

A. Make connections to equipment, motors, elevator controllers, lighting fixtures, and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings but called out by the equipment manufacturer's shop Drawings shall be provided.

3.11 CLEANING

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.
B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.12 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

A. Equipment and materials shall be protected from theft, injury or damage.
B. Protect conduit openings with temporary plugs or caps.
C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.13 EXTRA WORK

A. For any extra electrical work which may be proposed, this Contractor shall furnish to the Construction Manager, an itemized breakdown of the estimated cost of the materials, in unit prices, and labor required to complete this work. The Contractor shall proceed only after receiving a written order from the Construction Manager establishing the agreed price and describing the work to be done.

3.14 DRAWINGS AND MEASUREMENTS

A. The Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor’s responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

END OF SECTION 26 0010

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SECTION 26 0519
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. Section includes:
   1. Building wires and cables rated 600V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
B. Related Sections include the following:
   1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 SUBMITTALS

A. Submit letter of compliance (intent) for all building wire and cable. Include manufacturer for each wire and cable.

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.
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

D. Conductor Insulation:
   1. Type THHN/THWN-2: Comply with UL 83.
   2. Type THW/THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
   3. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers:
   1. AFC Cable Systems
   2. Alpha Wire Company
   3. American Bare Conductor
   4. Belden
   5. Encore
   6. General Cable
   7. Okonite
   8. Service Wire Co.
   9. Southwire Company

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Comply with UL 1569.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:
   1. Single circuit and multi-circuit with color-coded conductors for branch circuit distribution.
   2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors:
   1. Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated. Ground conductor sized as indicated on drawings (reduced ground conductor is not acceptable).

G. Conductor Insulation:
   1. Type TFN/THHN/THWN-2: Comply with UL 83.
   2. Type XHHW-2: Comply with UL 44.

H. Armor: Aluminum, interlocked.

2.3 POWER CABLE FOR VARIABLE FREQUENCY CONTROLLED MOTORS

A. Description: A factory assembly of three conductor cable with three symmetrical ground conductors, a continuous shield, an overall PVC jacket, and a product specific connector and termination kit.

B. Manufacturers:

1. Service Wire Co.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Comply with UL 1277
   3. Comply with ICEA S-95-658/NEMA WC 70 for Type TC-ER Power Cable (for VFD application)
   4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
D. Circuits:
   1. Single circuit feeder.
E. Phase Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
F. Ground Conductor: Bare copper.
G. Phase Conductor Insulation: Moisture resistant, flame retardant, cross linked polyethylene (2KV RHW-2) suitable for 90 deg C conductor temperature operation in dry, damp and wet locations.
H. Shield: Helically applied minimum 5 mils thick bare copper with minimum 50% overlap.
I. Armor: Aluminum, interlocked.
J. Jacket: Oil resistant PVC
K. Connector: Water-tight and UL listed for installation on supplied TC cable (tray cable) assembly.
   1. Body material: nickel clad aluminum
   2. Connector shall provide a 360-degree electrical bonding of the copper tape shield to the connector body.
   3. Connection of the copper tape shield to the connector body shall be accomplished by an integral and self-retaining grounding collar that automatically provides a 360-degree connection as the connector is tightened.
   4. The connector assembly shall be designed to ensure against loosening of threads due to vibration.
   5. A UL listed chrome plated grounding and bonding locknut with a 360-degree knurled teeth connection shall be provided with each connector to secure and bond the connector to the inverter cabinet / motor termination box.
   6. Tinned copper braids (minimum ¾ inches wide) with installation hardware to connect the copper tape shield to the inverter enclosure / back-panel and to the motor frame shall be provided as part of the cable system.
L. Termination Kit: Tinned copper braids (minimum ¾ inches wide) with installation hardware to connect the copper tape shield to cable core, to the inverter enclosure/back-panel, and to the motor frame shall be provided as part of the cable system.
   1. Braid width shall be determined by cable core diameter size and shall be placed at a separation of 180 degrees.

2.4 CONNECTORS AND SPLICES

A. 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. Provide conductors and cables in interior and exterior locations in accordance with the “Raceway / Conductor / Cable Application Schedule” included on the drawings.
B. Feeders and Branch Circuits: Solid or stranded for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).
D. Use conductor not smaller than 12 AWG for power and lighting circuits. Unless indicated otherwise, all circuits shall be 2#12, 1#12G, ¾"C.
E. Use conductor not smaller than 14 AWG for control circuits, provided by Electrical Contractor.
F. Where equipment is listed for use with copper conductors only, splice from aluminum to copper prior to entering equipment or use copper conductors for the entire length of feeder.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Refer to "Raceway / Conductor / Cable Application Schedule" included on the drawings for application requirements.
B. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel wire-mesh strain relief device at terminations to suit application.
C. Fire Alarm Circuits: Type THHN/THWN-2, in raceway.
D. Class 1 Control Circuits: Type THHN/THWN-2, in raceway.
E. Class 2 Control Circuits: Type THHN/THWN-2, in raceway or Power-limited cable, concealed in building finishes.
F. Connection between Variable Frequency Controllers and Motors: Use 600V rated VFC power cable for circuit lengths less than 50 feet and 2000V rated VFC power cable for circuit lengths 50 feet and greater. Support 5' on center, minimum. Terminate according to cable manufacturer's recommendations.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
B. Complete raceway installation between conductor and cable termination points according to Section 26 0533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
C. 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.
D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
G. Complete cable tray systems installation according to Division 26 Section "Cable Trays" prior to installing conductors and cables.
H. Support communication cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.
I. Neatly train and lace wiring inside boxes, equipment, and panelboards.
J. Branch circuits may be combined up to three circuits (a total of six current carrying conductors) circuits in a homerun conduit.
K. Provide a separate neutral conductor for each circuit unless multi-wire branch circuits are specifically indicated on the drawings.
L. Electrical Contractor shall be responsible for de-rating of conductors as required by N.E.C. when more than three current carrying conductors are installed in a single raceway or cable. Neutral conductors shall be considered current carrying conductors.

M. Do not route conductors across roof without prior approval from engineer. Where approved, conductors shall be installed in rigid steel conduit and shall be de-rated for ambient temperature per the NEC.
N. Install and terminate power cable for variable frequency-controlled motors according to cable manufacturer's recommendations.

3.4 SPECIAL REQUIREMENTS FOR USE OF MC CABLE

A. MC cable shall not be used for home runs to receptacle, lighting or distribution panels.
B. MC cable is allowed only from homerun junction box located within the perimeter of a space such as a classroom or office to light fixtures and wiring devices within partition walls serving that space.
C. For devices located in corridors, MC cable shall not be installed with horizontal lengths exceeding 10 feet.
D. MC cable shall be routed parallel and perpendicular to building structural elements both horizontally and vertically and be installed in a neat and workmanlike manner.
E. Type MC cable shall be supported and secured at intervals not exceeding 4'-0".
F. Do not use ceiling support wire to support MC cable except connections between lighting fixtures. Support from structural elements only or provide independent support between structural elements as required.
G. Between support, hangers and termination no more than 3" deflection from the bottom of the cable to a horizontal line between the support/hanger or termination.

3.5 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.
B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.
D. Clean conductor surfaces before installing lugs and connectors.
E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
F. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
G. Use Sta-Kon connectors to terminate stranded conductors #10 AWG and smaller to screw terminals.
H. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
I. Provide lugs suitable for bussing and conductor material used.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 0553 "Identification for Electrical Systems."
B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 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 Section 26 0533 "Raceways and Boxes."

3.8 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".

3.9 FIELD QUALITY CONTROL

A. Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”
   1. Description: Test all feeders rated 100 A and above.
   2. Visual and Mechanical Inspection
      a. Inspect cables for physical damage and proper connection in accordance with the one line diagram.
      b. Test cable mechanical connections with an infrared survey.
      c. Check cable color-coding against project Specifications and N.E.C. requirements.
   3. Electrical Tests
      a. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts dc for 1 minute.
      b. Perform continuity test to insure proper cable connection.
   4. Test Values
      a. Minimum insulation resistance values shall be not less than fifty mega-ohms.
B. 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.

END OF SECTION 26 0519

SECTION 26 0526
GROUNDING AND BONDING

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 grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
B. Related Sections include the following:
   1. Division 26 Section “Electrical General Requirements”.
   2. Division 26 Section “Conductors and Cables”.

1.3 REFERENCES

A. ASTM B 3: Specification for Soft or Annealed Copper Wire.
B. ASTM B 8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
C. ASTM B 33: Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
D. ASTM B 187: Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes.
E. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
F. IEEE 142: Grounding of Industrial and Commercial Power Systems.
G. IEEE 837: Qualifying Permanent Connections Used in Substation Grounding.
H. IEEE 1100 – 1992: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.
I. IEEE C2: National Electrical Safety Code.
J. NETA MTS – 2001: Maintenance Testing Specifications.

K. NFPA 70: National Electrical Code.
L. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.
M. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements Standard.
N. UL 467: Grounding and Bonding Equipment.
O. UL 486 A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.4 SUBMITTALS

A. Letter of Compliance.
B. Field Test Reports: Submit written test reports to include the following:
   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.
   4. Indicate overall system resistance to ground.
   5. Indicate overall Telecommunications system resistance to ground.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 26 “Electrical General Requirements”.
B. Accurately record actual locations of grounding electrodes and connections to building steel.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Refer to specification section “Electrical Testing.”
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. Comply with UL 467.
C. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.
D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
E. Comply with ANSI/TIA/EIA-607 “Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications”.
F. Comply with ANSI/IEEE 1100 -1992 “Powering and Grounding Sensitive Electronic Equipment”.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grounding Conductors and Cables:
      a. Refer to Division 26 Section “Conductors and Cables”.
   2. Grounding Rods:
      a. American Electric-Blackburn.
      b. Apache Grounding/Erico Inc.
      c. Chance/Hubbell.
   3. Mechanical Connectors:
      a. American Electric-Blackburn.
      b. Burndy.
      c. Chance/Hubbell.
   4. Exothermic Connections:
      a. Cadweld.
   5. Compression-type Connectors:
      a. Burndy HyGround

b. Blackburn EZ Ground.
c. Panduit.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
B. Material: Copper.
C. Equipment Grounding Conductors: Insulated with green-colored insulation.
D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
E. Grounding Electrode Conductors: Stranded cable.
F. Underground Conductors: Bare, stranded, copper unless otherwise indicated.
G. Bare Copper Conductors: Comply with the following:
   1. Solid Conductors: ASTM B 3.
   2. Assembly of Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.
H. Copper Bonding Conductors: As follows:
   1. Bonding Conductor: Stranded copper conductor; size per the NEC.
   2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; size per the NEC.
   3. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; size per the NEC.
I. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.
J. Telecommunications Main Grounding Busbar (TMGB)
   1. 48” (min) x 4” x ¼” tin plated, copper busbar with three rows of ¼ x 20 tapped holes 3” on center.
K. Telecommunications Grounding Busbar (TGB)
   1. 12” (min) x 2” x ¼” tin plated, copper busbar with two rows of ¼ x 20 tapped holes 3” on center.
L. Telecommunications Bonding Backbone (TBB)
   1. Minimum No. 2 AWG insulated stranded copper.
M. Telecommunications Bonding Conductors
   1. Minimum No. 6 AWG insulated stranded copper.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
C. Welded Connectors: Exothermic-welded type, in kit form, and selected for the specific application per manufacturer's written instructions.
D. Compression-Type Connectors: Pure, wrought copper, per ASTM B187.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.
   1. Size: 5/8 in diameter
   2. Length: 120 inches

PART 3 - EXECUTION

3.1 EQUIPMENT GROUNDING

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
C. In raceways, use insulated equipment grounding conductors.
D. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.
E. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
F. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.
G. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at the isolated ground bus in the circuit's overcurrent device enclosure unless otherwise indicated.
H. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
I. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
J. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
K. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a separate equipment grounding conductor with supply branch-circuit conductors. Bond pole and foundation reinforcing steel to equipment ground conductor.
L. Verify specific equipment grounding requirements with the manufacturer's recommendations.

3.2 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
C. Equipment Grounding Conductor Terminations
   1. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
   2. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.
F. 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.
G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.3 INSTALLATION

A. Equipotential Ground: Interconnect grounding electrodes to form one, electrically continuous, equipotential grounding electrode system Grounding electrodes to be interconnected include:
   1. Ground rods.
   2. Metal water service pipe.
B. Ground Rods: 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.
   1. Verify that final backfill and compaction has been complete before driving ground rods.
   2. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
   3. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Install in conduit where routed above grade.
   1. Aluminum and copper-clad aluminum conductors shall not be used in direct contact with masonry, within 18 inches of the earth, or where subject to corrosive conditions.
D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
E. Metal Water Service Pipe in direct contact with the earth for 10 feet or more: Provide 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 by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
H. Separately Derived AC Power Systems: Ground separately-derived ac power system neutrals including distribution transformers and uninterruptible power supplies to grounding electrodes per NFPA 70.
I. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor.
J. Grounding Bus:
    1. Install grounding bus in the locations listed below and elsewhere as indicated:
        a. Electrical equipment rooms.
        b. Telephone equipment rooms.
        c. Rooms housing service equipment.
    2. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
K. Equipment Grounding: Provide a permanent and continuous bonding of conductor enclosures, equipment frames, power distribution equipment ground busses, cable trays, metallic raceways, and other non-current carrying metallic parts of the electrical system.
L. Bond together metal building elements not attached to grounded structure; bond to ground.
M. Provide a flexible braid bonding jumper at each set of columns at expansion joints.

3.4 TELECOMMUNICATIONS GROUNDING

A. Telecommunications Grounding System: The telecommunications grounding system shall consist of:
    1. Telecommunications Main Grounding Busbar (TMGB) located in the main telecommunications room near the telecommunications service entrance. Bond to the main building electrical grounding electrode system via a No. 3/0 AWG copper ground conductor.
    2. A Telecommunications Grounding Busbar (TGB) in each telecommunications room, cabinets, etc.
    3. A Telecommunications Bonding Backbone (TBB) tying together the TMGB and each TGB.
    4. Bonding of all equipment racks, raceways, non-current carrying metallic equipment and surge protection devices within the telecommunications room to the TGB's or TMGB using approved bonding conductors. Each piece of equipment shall be bonded individually directly to the ground bus.
B. All bonding connections shall be installed at an accessible location for inspection and maintenance.
C. All telecommunications bonding connections shall be of an approved mechanical type connection. Do not use exothermic welds unless specifically indicated on the Drawings.
D. The physical routing shall, in general, follow the same path as the backbone cable system.
E. Bond each TGB directly to the building steel with a No. 6 AWG conductor.
F. Do not use TGB's as a power system ground connection unless specifically noted on the Drawings.
G. All bonding connectors and conductors shall be UL listed for the purpose intended.
H. Mount TMGB and TGB bus to backboard or wall using 2" standoff insulators.
I. Individually bond each piece of non-current carrying metallic equipment in the Telecommunications Room to the TGB.
J. Install continuous cable from the TMGB to the furthest TGB. Bond all TGB's to TBB with bare No. 3/0 AWG copper ground conductor and T-tap grounding hardware.

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”
   1. Inspect grounding and bonding system conductors and connections for tightness and proper installation and for compliance with the Drawings and Specifications.
   2. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
      a. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
      b. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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.
      c. Perform ground-impedance measurements utilizing either the intersecting curves method of the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81).

   3. Provide 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.
      a. Equipment Rated 500 kVA and Less: 10 ohms.
      b. Equipment Rated 500 to 1000 kVA: 5 ohms.
      c. Equipment Rated More Than 1000 kVA: 3 ohms.
      d. Substations and Pad-Mounted Switching Equipment: 5 ohms.
      e. Manhole Grounds: 10 ohms.
      f. The telecommunications grounding system shall have a maximum resistance of 1 ohm as measured from the TMGB ground to earth ground.

   4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526

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SECTION 26 0529
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. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
D. 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 SUBMITTALS

A. Letter of Compliance.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

1.7 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.
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. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   4. Channel Dimensions: Selected for applicable load criteria.
B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
D. 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.
E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
F. 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. 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. 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.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

2.3 ROOF MOUNTED CONDUIT AND EQUIPMENT SUPPORTS

A. General: Shop- or field- fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted conduit and equipment.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. B-Line by Eaton; Dura-Blok.
    2. MIRO Industries.
    3. Pentair Electrical & Fastening Solutions; Caddy Pyramid.
    4. Pipe Pier Support Systems; Pipe Piers.
C. Adjustable Compact Stand: Recycled rubber base unit with integral threaded coupling capable of accepting 3/8-16 threaded rod, or 1-5/8 inch by 1-5/8 inch metal strut and various supporting elements.
D. Multiple-Conduit and Equipment Stand: Assembly of bases, vertical and horizontal members, and conduit supports, for roof installation without membrane penetration.
    1. Bases: One or more adjustable compact stand bases.
    2. Vertical Members: Two or more protective-coated-steel channels.
    3. Horizontal Member: Protective-coated-steel channel.
    4. Supports: Standard strut clamps, hangers, and accessories.

2.4 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Division 6 Section "Rough Carpentry." Plywood sheets shall be free of all voids. Plywood shall have a minimum of two coats of fire-resistant, non-conducting paint applied to all sides of all sheets. Provide flush hardware and supports to mount plywood to wall. The provided hardware shall have sufficient strength to carry all anticipated loads including, but not limited to cabling, cable management and equipment racks.

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 slotted support 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:
      a. Two-bolt conduit clamps
      b. Single-bolt conduit clamps using spring friction action for retention in support channel.

D. Support single runs of MC cable using spring-steel clamps from suspended ceiling hangers, hanger wire or building structure at intervals not to exceed three feet. Do not support MC cable from ceiling grid.

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 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:
      a. Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
      b. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
      c. 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 support systems attached to substrate.

E. Slotted support systems applications:
   1. Indoor dry and damp Locations: Painted Steel
   2. Outdoors and interior wet locations: Galvanized Steel

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

G. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
H. Obtain permission from Architect/Engineer before using powder-actuated anchors.
I. Obtain permission from Architect/Engineer before drilling or cutting structural members.
J. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
K. Install surface-mounted cabinets and panelboards with minimum of four anchors.
L. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.
M. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
N. The Contractor shall replace all supports and channels that sag, twist, and/or show signs of not providing proper structural support, to the equipment, it is intended for, as determined by the Owner and Architect/Engineer. All costs associated with replacing supports and steel channels shall be incurred by the Contractor.
O. Do not use C-clamps to support from structural steel. Use beam clamps only.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 INSTALLATION OF ROOF MOUNTED SUPPORTS

A. Install in accordance with manufacturer’s instructions.
B. If gravel top roof, gravel must be removed around and under support.
C. Consult roofing manufacturer for roof membrane compression capacities. If required, a compatible sheet of roofing material (rubber pad) may be required under rooftop support to disperse concentrated loads and add further membrane protection.
D. Utilize properly sized clamps and accessories to suit conduit sizes.
E. Provide vertical steel channel members as required for elevated conduit supports where required for clearances, coordination with other roof mounted systems or derating.

3.5 CONCRETE BASES

A. Provide concrete bases for all floor mounted electrical equipment.
B. Provide concrete bases for all exterior, grade level electrical equipment, and where indicated.
C. Base/Pad Construction:
    1. Construct per manufacturer’s recommendations for particular equipment, including suggested piers and dowel rods.
    2. Interior concrete bases shall have a minimum depth of 4” unless other indicated or recommended by the manufacturer.
    3. Exterior concrete bases shall have a minimum depth of 8” unless other indicated or recommended by the manufacturer.
    4. Construct concrete bases for primary and secondary power distribution equipment per requirements of the electrical utility, where submitted for its review.
D. Anchor equipment to base per both supports and equipment manufacturer’s instructions.
E. Coordinate conduit openings and sleeve locations in base with requirements of equipment to be supported.

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 the base.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

3.6 BACKBOARDS

A. A minimum of two walls (or as indicated on drawings) shall be covered with plywood backboards to a minimum 8'-6" above finished floor in all Telecommunication Rooms and similar spaces and as indicated on Drawings.
B. Securely fasten backboard to wall using appropriate hardware and mount at all four corners, minimum. Securely fasten backboard to wall-framing members (studs).
C. Provide adequate backboard space to allow a clean and workable arrangement for telephone and data connections.

3.7 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 26 0529

SECTION 26 0533
RACEWAYS AND BOXES

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
B. Related Sections include the following:
   1. Division 07 Section, “Penetration Firestopping” for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
   2. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings, and for access floor boxes and service poles.
   3. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

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.
H. PVC: Polyvinyl Chloride.
I. HDPE: High Density Polyethylene.
J. RTRC: Reinforced Thermosetting Resin Conduit

1.4 SUBMITTALS

A. Letter of Compliance.

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.

1.6 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, 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 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 Triangle Century.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. International Metal Hose.
   6. Electri-Flex Co
   7. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
   8. LTV Steel Tubular Products Company – Manhattan/CDT/Cole-Flex.
   9. Maverick.
   10. O-Z Gedney; unit of General Signal.
   11. Wheatland.
B. Rigid Steel Conduit: ANSI C80.1.
C. IMC: ANSI C80.6.
D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.
E. EMT: ANSI C80.3.
F. FMC: Zinc-coated steel
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. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
   2. Fittings for EMT: Steel, set-screw or compression type.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 FIRE ALARM EMT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Tube Triangle Century.
B. EMT conduit with bright red topcoat; Fire Alarm EMT.
C. EMT and Fittings: ANSI C80.3.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American International.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corp.
   4. Cantex Inc.
   5. Certainteed Corp.; Pipe and Plastics Group.
   6. Condux International.
   7. ElecSys, Inc.
   8. Electri-Flex Co.
   9. Integral.
   10. Kor-Kap.
   11. Lamson and Sessions: Carlon Electrical Products.
   12. Manhattan/CDT/Cole-Flex.
   13. RACO; Division of Hubbell, Inc.
   14. Scepter.
   15. Spiralduct, Inc./AFC Cable Systems, Inc.
   16. Thomas & Betts Corporation.
B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
C. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.
D. LFNC: UL 1660.
E. HDPE: UL 651, ASTM D 3350, ASTM D 1248 Schedule 40.
F. RTRC: Comply with UL 2515A and NEMA TC 14.

2.4 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hoffman.
   2. Square D.
B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.
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. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
E. Wireway Covers: Screw-cover type.
F. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Airey-Thompson Sentinel Lighting: Wiremold Company (The).
      b. Thomas & Betts Corporation.
      c. Walker Systems, Inc.; Wiremold Company (The).
      d. Wiremold Company (The); Electrical Sales Division.

e. Mono-Systems, Inc.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.
C. Quantity and types of receptacles and telecom outlets as shown on plan.
D. Finish selected by architect.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1. Shall be used within walls or ceiling.
B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Shall be used in all exposed, non-recessed, locations.
C. Nonmetallic Outlet and Device Boxes: NEMA OS 2. Shall be used in corrosive areas.
D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
E. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover. Shall be used in areas exposed to water.
F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
G. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with ANSI/SCTE 77.
   1. Color of Frame and Cover: Gray where located in concrete and green where located in landscaping.
   2. Configuration: Units shall be designed for flush burial and have open 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, "ELECTRIC", “COMMUNICATIONS” or as indicated for each system service.
   6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
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. 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. Hubbell: Quazite
      b. Armorcast Products Company.
      c. Carson Industries LLC.
      d. CDR Systems Corporation.
      e. NewBasis.
      f. Christy Concrete Products.

2.8 SLEEVES FOR RACEWAYS

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 water stop, unless otherwise indicated.
C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.9 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 Co.
   4. Pipeline Seal and Insulator, Inc.
B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Plastic. Include two for each sealing element.
   3. 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.

2.10 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.11 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Provide raceways in interior and exterior locations in accordance with the “Raceway Application Matrix” included on the drawings.
B. Boxes and Enclosures, Exterior Aboveground: NEMA 250, Type 4.
C. Boxes, Enclosures, and Handholes:
   1. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
   2. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.

D. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.
E. Minimum Raceway Size: 3/4-inch trade size
F. 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. EMT: Use setscrew and compression fittings. Comply with NEMA FB 2.10.
   4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
G. Install surface raceways only where indicated on Drawings.
H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
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. Install temporary closures to prevent foreign matter from entering raceways.
F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
I. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
   1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
J. Support conduit within 12 inches of enclosures to which attached.
K. Raceways Embedded in Slabs:
   1. Raceways embedded in slabs shall be limited to above grade concrete decks. Embedded conduit shall be limited to servicing floor boxes and equipment located in open spaces away from accessible walls.
   2. Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
   3. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   4. Space raceways laterally to prevent voids in concrete.
   5. 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.
   6. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   7. Conduits shall run flat. Do not allow conduits to cross.

8. Change from non-metallic raceway to rigid steel before turning up out of the concrete and rising above the floor.

L. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
   1. Run parallel or banked raceways together on common supports.
   2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. 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.

S. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

T. 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.

U. Provide pull string and 25% spare capacity in every branch circuit conduit.

V. Communications and Signal Cabling Systems Raceways: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
   1. Electrical condulet (LB’s) are not permitted.
   2. Conduits shall have no more than two 90 degree bends between pull points or pull boxes.
   3. Conduits shall contain no continuous sections longer than 150 ft. without a pull point/box.
   4. Conduit for fiber cabling shall have a bend radius of at least 10 times the internal diameter.
   5. Conduit for copper cabling less than 2” shall have a bend radius of at least 6 times the internal diameter. Conduit for copper cabling 2” and larger shall have a bend radius of at least 10 times the internal diameter.
   6. All conduit ends shall have an insulated bushing.

W. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

X. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   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 Outdoors without Physical Separation: 125 deg F temperature change.
3. 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 for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Y. Flexible Conduit Connections: Comply with NEMA RV3. Use maximum of 72 inches of flexible conduit for recessed and semi recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

Z. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals. Provide cover clips to cover space between connecting pieces.

AA. 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.

BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. This is to prevent sound transmission between adjoining rooms.

CC. Locate boxes so that cover or plate will not span different building finishes.

DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

FF. Set floor boxes level and flush with finished floor surface. Trim non-metallic boxes after installation to fit flush with finished floor surface.

GG. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

HH. Do not route feeders across roof.

II. Provide a pull box (a handhole for outdoor applications) for each conduit run that exceeds 250 feet. Provide two pull boxes (handholes for outdoor applications) for runs that exceed 500 feet.

JJ. Route conduits in finished areas with exposed ceilings at underside of structural deck or as high as possible.

KK. Outlet boxes within hazardous locations shall be of the proper class and division as noted in the N.E.C.

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 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Division 2 Section "Earthwork."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
   4. 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 inches of concrete.
      b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
   5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks 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 handholes and boxes with bottom below the frost line, 42” below grade.
E. 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.
F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL AND COMMUNICATIONS PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Through-Penetration Firestop Systems."
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. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.

2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. 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.
F. Cut sleeves to length for mounting flush with both surfaces of walls.
G. Extend sleeves installed in floors 2 inches above finished floor level.
H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.
I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."
L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
M. Aboveground, Exterior-Wall 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.
N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.
B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 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 "Through-Penetration Firestop Systems."

3.8 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.

3.9 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 0533

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SECTION 26 0536
CABLE TRAYS

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 cable trays and accessories for telecommunications cable.
B. Related Sections include the following:
   1. Division 7 Section under “Through Penetration Firestop Materials" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
   2. Division 27 Section “Communications Equipment Room Fittings.”

1.3 SUBMITTALS

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.
B. Shop Drawings: For each type of cable tray.
   1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
C. Coordination Drawings: Floor plans and sections drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural and mechanical elements. Show the following:
   1. Vertical and horizontal offsets and transitions.
   2. Clearances for access above and to side of cable trays.
   3. Vertical elevation of cable trays above floor or bottom of ceiling structure.
D. Field Test Reports: Written reports for grounding of cable tray as specified in Part 3.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.
B. Source Limitations: Obtain cable tray components through one source from a single manufacturer.
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. Comply with NEMA VE 1, "Metal Cable Tray Systems," if cable tray types specified are defined in the standard.
E. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of cable trays 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 WIRE BASKET SUPPORT SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. B-Line Flex-Tray.
   2. Cablofil – EZ Tray – Wire-mesh.
   3. P-W Industries, Inc. – Wire mesh.
   4. Wiremold.
   5. Mono-Systems, Inc.
B. Description: Continuous, welded steel wire mesh construction, 2” x 4” longitudinal and lateral spacing orientation respectively, width and load depth as indicated with mounting hardware to secure in place.
C. Material: ASTM A510 high strength steel wires.
D. Finish: Natural electrostatic, powder-coat paint finish for tray and all fittings.
E. Inside Width: As indicated on plan.
F. Inside Depth: As indicated on plan.
G. Inside Radius Fittings: As recommended based on width of tray.
H. Provide manufacturer’s standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, inside radius fittings, can grounding straps. All splicing connectors shall be UL listed for bonding or #6 AWG copper bonding conductors shall be installed at all splices of separate cable tray sections.
I. Wall brackets shall be Cablofil CRP Reinforced Bracket, or equivalent, sized as required to bear full width of cable tray.
J. Provide lay-in lugs for grounding and bonding cable tray.
K. Provide cable roller kit, Cablofil FAS Roller, or equivalent, including all mounting hardware.

2.2 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA VE 1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions 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 CABLE TRAY INSTALLATION

A. Remove burrs and sharp edges from cable trays.
B. Fasten cable tray supports securely to building structure as specified in Division 26 Section "Hangers and Supports for Electrical Systems," unless otherwise indicated.
   1. Locate and install supports according to NEMA VE 1.
C. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed 90 feet. Space connectors and set gaps according to NEMA VE 1.
D. Make changes in direction and elevation using standard fittings.
E. Make cable tray connections using standard fittings.
F. Locate cable tray above piping unless accessibility to cable tray is required or unless otherwise indicated.
G. Seal penetrations through fire and smoke barriers according to Division 7 Section "Through-Penetration Firestop Systems."
H. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
I. Workspace: Install cable trays with sufficient space to permit access for installing cables.
J. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.
K. Support trays in accordance with Division 26 Section “Hangers and Supports for Electrical Systems”. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports of 10 ft maximum, in general, and 6 feet maximum for wall-mounted tray in Telecom spaces.
L. Spacing of supports shall be less than the span length of straight sections in all cases. Refer to NEMA VE2.
M. Support ladder type tray from trapeze hangers unless noted as wall bracket mounted. Do not use center hung supports. Use manufacturer standard wall brackets in lieu of field fabricated.
N. Ground and bond cable tray. Provide continuity between tray components. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly. Bond tray to ground minimum every 100' or at each end, and at all locations required by NEMA VE2 with a minimum #1 AWG copper insulated ground wire.
O. Cable tray shall be installed physically continuous for the complete run as shown on Drawings. Sprinkler piping, metal studs, ductwork, conduit, etc. shall not interfere with the wiring space provided by the cable tray or access to the cable tray.
P. Coordinate with the installation of ductwork, sprinkler piping, etc. to provide cable tray access of at least 6" above the top of the tray run and at least 12" on each side of the tray.
Q. Where cable tray passes through fire rated walls, provide firestop pillows as specified for rating as required. Refer to Architectural Drawings for locations of rated walls.
R. Where cable tray passes through floors or walls requiring smoke tight construction, provide 3M composite sheets and moldable putty to develop a smoke tight installation after all cables have been installed.
S. Support cable tray independently of other systems and do not use cable tray or its supports for supporting other systems.
T. Provide lateral or transverse supports for cable tray to prevent swaying.

3.3 WIRE BASKET SUPPORT SYSTEMS INSTALLATION

A. Install wire basket as indicated; in accordance with recognized industry practices (NEMA VE-2 2000), to ensure that the cable tray equipment complies with requirements of NEC, and applicable portions of NFPA 70B and NECA’s “Standards of Installation” pertaining to general electrical installation practices.
B. Coordinate wire basket with other electrical work as necessary to properly interface installation of wire basket runway with work of other trades.

C. Provide sufficient space encompassing wire basket to permit access for installing and maintaining cables.

3.4 CONNECTIONS

A. Ground cable trays according to manufacturer's written instructions.

B. 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.

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing wire basket support systems and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform the following electrical test and visual and mechanical inspections:
   a. Visually inspect each cable tray joint and each ground connection for mechanical continuity.
   b. Measure ground resistance of each system of cable tray from the most remote element to the point where connection is made to service disconnect enclosure grounding terminal. Record resistance in ohms.
3. Report results in writing.

3.6 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure wire basket support systems is without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 26 0536

SECTION 26 0553
ELECTRICAL IDENTIFICATION

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. Identification for raceway and metal-clad cable.
   2. Identification for conductors and communication and control cable.
   3. Underground-line warning tape.
   4. Warning labels and signs.
   5. Equipment identification labels.
   6. Miscellaneous identification products.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70.
B. Comply with 29 CFR 1910.145.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, 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 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
B. Color for Printed Legend:
   1. Power Circuits: Black letters on an orange field.
   2. Legend: Indicate system or service and voltage, if applicable.
C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 CONDUCTOR, COMMUNICATION 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.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
   1. Not less than 6 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. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
C. 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 FOR 36 INCHES."

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 3/8 inch.
B. Outdoor Equipment Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, 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.
B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.
C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service and Feeders More Than 400 A: Identify with orange self-adhesive vinyl label.

C. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
   1. Fire Alarm System: Red.
   2. Security System: Blue and yellow.
   3. Telecommunication System: Green and yellow.
   4. Control Wiring: Green and red.
   5. Temperature Control System: Green

D. Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape and marker tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

E. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number as indicated on Drawings. Identify control circuits by control wire number as indicated on shop drawings.

F. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.

G. Conductor Identification: Locate at each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection or termination point.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, 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 Operation and Maintenance Manual.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
   1. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and 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. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label mechanically secured.
b. Outdoor Equipment: Stenciled.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled: If included on project. All items may not be on project.
a. Panelboards, electrical cabinets, and enclosures.
b. Access doors and panels for concealed electrical items.
c. Electrical switchgear and switchboards.
d. Transformers.
e. Electrical substations.
f. Disconnect switches.
g. Enclosed circuit breakers.
h. Motor starters.
i. Push-button stations.
j. Contactors.
k. Remote-controlled switches, dimmer modules, and control devices.
l. Battery inverter units.
m. Voice and data cable terminal equipment.
n. Master clock and program equipment.
o. Fire-alarm control panel and annunciators.
p. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
q. Monitoring and control equipment.
r. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
s. Breakers or switches at distribution panels.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.
B. Location:
1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
2. Conduit Markers: Provide identification for each power conduit containing conductors rated 400A or greater.
C. Apply identification devices to surfaces after completing finish work.
D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands 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.
G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
2. Colors for 208/120-V Circuits:
a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.
d. Grounded Conductor (Neutral): White.
3. Colors for 480/277-V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.
d. Ground Conductor (Neutral): Grey.

4. 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. Label information arrangement for 3 lines of text.
1. Line one shall describe the panel or equipment. Line one example: “DP-XX,” RP-XX,” “T-XX,” “EF-XX,” etc.
2. Line two shall describe the first disconnecting means feeding this panel or equipment. Line two example: “Fed from DP-XX,” “Fed from RP-XX,” etc.
3. Line three indicates that location of the disconnecting means as identified in line two. Line three example: “First Floor Elect. Rm #XXX.”
4. Line four shall include “Via T-XX” when panel or equipment is fed from a transformer.

J. Examples:

RP-1A FED FROM DP-1A ELECTRICAL ROOM A100 VIA T-1A	EF-1 FED FROM MCC-1A MECHANICAL ROOM F101	LP-1A LOCATED IN ELECTRICAL ROOM A100

K. Fusible Enclosed Switches and Distribution Equipment: Install self-adhesive vinyl label indicating fuse rating and type on the outside of door on each fused switch.

L. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

M. Degrease and clean surface to receive nameplates.

N. Install nameplate and labels parallel to equipment lines.

O. Secure nameplate to equipment front using screws.

P. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

Q. Identify conduit using field painting where required.

R. Paint red colored band on each fire alarm conduit and junction box.

S. Paint bands 10 feet on center, and 4 inches minimum in width.

END OF SECTION 26 0553

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SECTION 26 0573
OVERCURRENT DEVICE COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

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 of this section.

1.2 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer.
B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D prepared by the electrical equipment manufacturer.
C. The scope of the studies shall include all new distribution equipment supplied by the equipment manufacturer under this contract as well as all directly affected existing distribution equipment at the customer facility.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
   2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
   3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
   4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
   5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):
   1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
   2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
   3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
   4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)
   1. NFPA 70 -National Electrical Code, latest edition
   2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination 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 drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Report shall be provided on electronic media. All literature shall be combined in one document and shall be properly bookmarked with all applicable sections.

B. The report shall include the following sections:
   1. Executive Summary.
   2. Descriptions, purpose, basis and scope of the study.
   3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
   4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
   5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
   6. Details of the incident energy and flash protection boundary calculations.
   7. Recommendations for system improvements, where needed.
   8. One-line diagram.

C. Arc flash labels shall be provided in hard copy and a copy of the computer analysis software viewer program is required to provide arc flash labels in electronic format.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The equipment manufacturer shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.7 COMPUTER SOFTWARE PROGRAMS

A. Computer Software Programs: Subject to compliance with requirements, provide products by one of the following:
   1. EDSA Micro Corporation.
   2. SKM Systems Analysis, Inc.
   3. ESA Inc.
   4. CGI CYME.
   5. Operation Technology, Inc.

PART 2 - PRODUCTS

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.
B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D prepared by the equipment manufacturer.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
B. Source combination may include present and future motors and generators.
C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner.
D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.
B. Transformer design impedances shall be used when test impedances are not available.
C. Provide the following:
   1. Calculation methods and assumptions
   2. Selected base per unit quantities
   3. One-line diagram of the system being evaluated
   4. Source impedance data, including electric utility system and motor fault contribution characteristics
   5. Tabulations of calculated quantities
   6. Results, conclusions, and recommendations.
D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
   1. Electric utility’s supply termination point
   2. Incoming switchgear
   3. Unit substation primary and secondary terminals
   4. Low voltage switchgear
   5. Motor control centers
   6. Standby generators and automatic transfer switches
   7. Branch circuit panelboards
   8. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
F. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short circuit ratings
   2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
   3. Notify design engineer in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.
B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.
C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
E. Plot the following characteristics on the TCC graphs, where applicable:
   1. Electric utility's overcurrent protective device
   2. Medium voltage equipment overcurrent relays
   3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
   4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
   5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
   6. Conductor damage curves
   7. Ground fault protective devices, as applicable
   8. Pertinent motor starting characteristics and motor damage points, where applicable
   9. Pertinent generator short-circuit decrement curve and generator damage point
   10. The largest feeder circuit breaker in each motor control center and applicable panelboard.
F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.
E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must

be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:
   1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
   2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
   3. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X”d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
   4. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
B. Short-Circuit Output Data shall include, but not be limited to the following reports:
   1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
      a. Voltage
      b. Calculated fault current magnitude and angle

c. Fault point X/R ratio
d. Equivalent impedance

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated symmetrical fault current magnitude and angle
   c. Fault point X/R ratio
   d. Calculated asymmetrical fault currents
      1) Based on fault point X/R ratio
      2) Based on calculated symmetrical value multiplied by 1.6
      3) Based on calculated symmetrical value multiplied by 2.7
   e. Equivalent impedance
3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated symmetrical fault current magnitude and angle
   c. Fault point X/R ratio
   d. No AC Decrement (NACD) Ratio
   e. Equivalent impedance
   f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
   g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
   a. Current transformer ratio
   b. Current setting
   c. Time setting
   d. Instantaneous setting
   e. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
   a. Adjustable pickups and time delays (long time, short time, ground)
   b. Adjustable time-current characteristic
   c. Adjustable instantaneous pickup
   d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations
1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. The contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
C. Notify design engineer in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

A. The contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
C. The label shall include the following information, at a minimum:
    1. Location designation
    2. Nominal voltage
    3. Flash protection boundary
    4. Hazard risk category
    5. Incident energy
    6. Working distance
    7. Engineering report number, revision number and issue date.
D. Labels shall be machine printed, with no field markings.
E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
    1. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
    2. For each motor control center, one arc flash label shall be provided.
    3. For each low voltage switchboard, one arc flash label shall be provided.
    4. For each switchgear, one flash label shall be provided.
    5. For medium voltage switches one arc flash label shall be provided
F. Labels shall be field installed by the contractor.

END OF SECTION 26 0573

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SECTION 26 0923
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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:
   1. Outdoor photoelectric control.
   2. Lighting contactors.
B. Related Sections include the following:
   1. Division 26 Section “Electrical General Requirements”.
   2. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.
   3. Division 26 Section "Lighting Control Systems" for programmable lighting systems.

1.3 REFERENCES

A. IEEE C62.41: Guide for Surge Voltages in Low-Voltage AC Power Circuits.
B. NFPA 70: National Electrical Code.
C. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
D. UL 773: Plug-in, Locking Photocontrols for Use with Area Lighting.
E. UL 773A: Nonindustrial Photoelectric Switches for Lighting Control.
F. UL 917: Clock Operated Switches.
G. UL 1449: Surge Protective Devices.
H. UL 1598: Luminaires.
I. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated including physical data and electrical performance.
B. Shop Drawings: Interconnection diagrams showing field-installed wiring.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. Include the following:
   1. Description of operation and servicing procedures.
   2. List of major components.
   3. Recommended spare parts.
   4. Programming instructions and system operation procedures.

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 COORDINATION

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, fire-suppression system, and partition assemblies.
B. Coordinate interface of lighting control devices with temperature controls specified in Division 23.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 26 Section “Electrical General Requirements”.
B. Store and protect products under provisions of Division 26 Section “Electrical General Requirements”.

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.2 OUTDOOR PHOTOELECTRIC CONTROL

A. Manufacturers:
   1. Intermatic, Inc.
   2. Square D.
   3. TORK.
B. General
   1. Provide fully-gasketed, weathertight enclosure constructed of die cast zinc, with one-half inch conduit nipple for mounting purposes, and with positioning lug to permit full 360-degree adjustable orientation of photocell.
   2. Provide hermetically-sealed, one-inch-diameter, cadmium sulphide photoelectric cell with manual, light level selector.
   3. Provide photoelectric control suitable for an operating temperature range of minus 40 degrees F to plus 140 degrees F.
C. Description: Solid state, with dry contacts rated to operate connected load, relay, contactor coils, or microprocessor input, and complying with UL 773A.
   1. Light-Level Monitoring Range: Adjustable turn-on range of 1 to 5 fc (11 to 54 lux) and adjustable turn-off range of 3 to 15 fc (32 to 1662 lux).
   2. Time Delay: Adjustable delay up to two minutes to prevent false operation.

3. Contacts: Normally closed, fail on.
4. Electrical: Provide photocell with operating voltage rated to switch the load directly unless otherwise indicated.
5. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category A1 locations.
6. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.
7. Provide hermatically-sealed, one inch diameter, cadmium sulphide photoelectric cell with manual, 2 to 50 footcandle, light level selector.

2.3 LIGHTING CONTACTORS

A. Manufacturers:
   1. Cutler-Hammer; Eaton Corporation.
   2. Square D Co.
   3. General Electric.
   4. Siemens.
   5. Square D Co; class 8903.

B. Contactor
   1. Electrically-operated electrically-held contactor per NEMA ICS2, with 120 volt, 60 hertz coil and 600 volt, 60 hertz, contacts. Refer to plans for ampere and poles required
   2. Provide contacts to be 100 percent, continuously rated for all types of ballast and tungsten lighting and resistance loads without the need for in-rush current derating.
   3. Provide NEMA type 1 enclosure unless otherwise indicated.
   4. Provide corrosion-resistant primer treatment with light gray baked acrylic enamel finish.
   5. Provide the following control and indicating devices:
      a. Auxiliary contacts: One field convertible.
      b. Auxiliary relay to convert maintained-contact type control circuit to momentary-contact type control circuit necessary for contactor control.
      c. Control transformer with primary voltage as indicated and 120-volt, single phase, 60 hertz secondary including fuse and fuseholder.
      d. Green pilot light to indicate “power on” condition. Mount on front cover with legend plate.

PART 3 - EXECUTION

3.1 LIGHTING CONTACTOR INSTALLATION

A. Install lighting contactors as indicated on plan. Install at accessible locations. Switch controls where provided shall be no higher than 54” or lower than 48”.
B. Demonstrate proper operation of all lighting control functions to the Owner and Engineer.

3.2 OUTDOOR PHOTOELECTRIC CONTROL INSTALLATION

A. Mount photocell on roof or parapet to ½” GRS conduit, supported to building structure below. Coordinate roof penetration with roofing contractor.
B. Install photoelectric control oriented in the northeast direction and not within any potential shadows.
C. Adjust photocell sensitivity and delay to meet owner’s requirements. Multiple adjustments may be required, as needed.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Conductors and Cables".

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. 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.
E. 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 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."
B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
   2. Operational Test: Verify actuation of each sensor and adjust time delays.
B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 26 0923

SECTION 26 0943
LIGHTING CONTROL 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.

1.2 SUMMARY

A. This Section includes the design and installation of programmable automatic lighting controls with all input and control devices necessary to meet the performance indicated on the contract drawings and this specification.
B. Related Sections include the following:
   1. Division 26 Section “LED Interior Lighting” for luminaire specifications and accessories.
   2. Division 26 Section "Lighting Control Devices" for photoelectric control and multi-pole contactors.

1.3 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.
B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
C. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.
D. LED: Light-emitting diode.
E. PIR: Passive infrared.
F. ULTRASONIC: Active emission of at least 35 kHz sound waves, using Doppler reflectance to detect motion.
G. MICROPHONIC: Passive reception to listen for continued occupancy, with circuitry to filter out white noise.
H. MULTI-Tech: Using PIR and ultrasonic or microphonic technologies in one sensor.

1.4 SUBMITTALS

A. Product Data: Indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature for all sensors, relays, dimming modules, control stations and other devices necessary for complete operation of the system.
B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
    1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements for all system components requiring field installation.
        a. Indicate location, orientation, and coverage area for each occupancy sensor.
    2. Riser Diagram: Show interconnection between all system components.
        a. Identify complete data communication backbone and interconnection between sensors, relays, dimming modules control stations and other components.
        b. Identify typical room/area type configurations.
        c. Indicate interconnections with emergency egress lighting relays and transfer devices required.
    3. Information Technology (IT) connection: Provide information pertaining to interconnection with facility IT networking equipment and third-party systems.
    4. Other Diagrams and Operational Descriptions – as needed to indicate system operation or interaction with other system(s).
    5. Contractor startup and commissioning worksheet.
    6. Custom engraving for control stations.
C. Submit qualifications of commissioning agent and draft functional test plans for review and approval.
D. Field quality-control test reports and commissioning worksheets
E. Software licenses and upgrades required by and installed for operation and programming of digital devices.
F. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals. Include the following:
    1. Software manuals.
    2. Operation of adjustable zone controls.
    3. Description of operation and servicing procedures.
    4. List of major components and recommended spare parts.
    5. Programming instructions.
    6. System operation and integration instructions.
G. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer with total responsibility for compatibility of lighting control system components specified in this Section.
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 47 CFR, Subparts A and B, for Class A digital devices.
D. Comply with NFPA 70.
E. Listed as qualified under Design Lights Consortium (DLC) Networked Lighting Control System Specification V2.0.
F. System luminaires and controls are certified by manufacturer to have been designed, manufactured and tested for interoperability.
G. Comply with ASHRAE 90.1 – 2013.

1.6 COORDINATION

A. Coordinate lighting control components specified in this Section and with systems and components specified in other Sections to form an integrated interconnection of compatible components.
B. Match components and interconnections for optimum performance of lighting control functions.
C. Provide open protocol interface for interoperability with building automation system including status of occupancy/vacancy sensors, control stations, time schedules, display graphics and status of lighting controls in each area.
D. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
E. Coordinate lighting controls with devices specified in Division 26 Section “Lighting Control Devices”.
F. Coordinate interface of lighting control devices with temperature controls specified in Division 23.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.
    1. Warranty Period: Five years from date of Substantial Completion.

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. Occupancy Sensors: Quantity equal to five of each type and rating.
    2. Batteries for all sensors and switches: Quantity equal to 10% percent of each type and size, but no fewer than 10 of each type and size.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
B. 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 revise licenses for use of the software.

1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

1.10 SYSTEM COMMISSIONING

A. Provide the services of a third party, independent agent to perform functional testing and verification of the lighting control system to comply with the requirements of ASHRAE 90.1 – 2013.
B. Perform functional testing of all lighting control system operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Lutron Vive
   2. Acuity Controls nLight

2.2 SYSTEM PERFORMANCE REQUIREMENTS

A. System Architecture
   1. System shall have an architecture that is based upon three main concepts: (a) networkable intelligent lighting control devices, (b) standalone lighting control zones using distributed intelligence, (c) system backbone for remote, time based and global operation between control zones.
      a. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible so as to minimize overall device count of system.
      b. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wall stations without requiring connection to a higher level system backbone; this capability is referred to as “distributed intelligence.”
      c. System must be capable of interfacing directly with networked luminaires such that either low voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches and system backbone.
   2. The system shall provide individually addressable switching and dimming control of the following: networked luminaires, control zones to include multiple switch legs or circuits, and relay and dimming outputs from centralized panels to provide design flexibility appropriate with sequence of operations required in each project area or typical space type. A single platform shall be used for both indoor and outdoor lighting controls.
   3. Lighting control zones shall be networked with a higher level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software.
   4. All system devices shall support remote firmware update, such that physical access to each device is not necessary, for purposes of upgrading functionality at a later date.
   5. System shall be capable of “out of box” sequence of operation for each control zone. Standard sequence is:
      a. All switches control all fixtures in a zone

b. All occupancy sensors automatically control all fixtures in the control zone with a default timeout.
c. All photocell sensors automatically control all fixtures in the control zone with a default footcandle level.

B. Wired Networked Control Zone Characteristics
1. All networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g., software application, handheld remote, pushbutton). The “out of box” default sequence of operation is intended to provide typical sequence of operation so as to minimize the system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.
2. System shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.
3. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:
a. Low-Voltage power sensing: These devices shall automatically provide 100% light level upon detection of loss of power sensed via the low voltage network cable connection.
b. UL924 Listed Line-Voltage power sensing: These devices shall be listed as emergency relays under the UL924 standard, and shall automatically close the load control relay(s) and provide 100% light output upon detection of loss of power sensed via line voltage connections.
c. Emergency egress devices shall be provided and UL labeled by the lighting control manufacturer.

C. Wireless Networked Control Zone Characteristics
1. All wireless networked devices paired, meshed or grouped together shall automatically follow the “out of box” default sequence of operations.
2. Wireless network communication shall support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wall station signal.
3. To support the system architecture requirement for distributed intelligence, wireless network communication shall support communication of control signals from sensors and wall stations to networked luminaires and wireless load control devices, without requiring any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge or gateway.
4. All wireless communication shall be encrypted using at least 128-bit Advanced Encryption Standard (AES).
5. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:
a. UL924 Listed Line-Voltage power sensing: These devices shall be listed as emergency relays under the UL924 standard, shall automatically close the load control relay(s), and provide 100% light output upon detection of loss or interruption of power sensed via line voltage connections.

D. System Integration Capabilities
1. The system shall be capable of interface with third party building management systems (BMS) to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP protocols.
a. Systems utilizing a third-party converter or systems that require a dedicated server to achieve integration are not acceptable.

2.3 SYSTEM SOFTWARE INTERFACES

A. Management Interface

1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
2. Management interface must be compatible with industry-standard web browser clients, including, but not limited to, Microsoft Internet Explorer®, Apple Safari®, Google Chrome®, Mozilla Firefox®.
3. All system software updates must be available for automatic download and installation via the internet.

B. Historical Database and Analytics Interface
1. System shall provide a browser-based trending and monitoring interface that stores historical data for all occupancy/daylight sensors and lighting loads. Additionally, the system shall optionally upload that data to a cloud based server.

C. Visualization Interfaces
1. System shall provide an optional web-based visualization interface that displays a graphical floorplan. System data, to include status of occupancy sensors, daylight sensors and light output shall be overlaid to the floorplan to provide a graphical status page.

D. Portable Programming Interface for Standalone Control Zones
1. Portable handheld application interface for standalone control zones shall be provided for systems that allows configuration of lighting control settings.
2. Programming capabilities through the application shall include, but not be limited to, the following:
   a. Switch, occupancy and photo sensor group configuration
   b. Manual/automatic on modes
   c. Turn-on dim level
   d. Occupancy sensor time delays
   e. Dual technology occupancy sensors sensitivity
   f. Photo-sensor calibration adjustment and auto-setpoint
   g. Trim level settings

2.4 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

A. System Controller
1. System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
2. System Controller shall perform the following functions:
   a. Facilitation of global network communication between different areas and control zones.
   b. Time-based control of downstream wired and wireless network devices.
   c. Linking into an Ethernet network.
   d. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
   e. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
3. System Controller shall not require a dedicated PC or a dedicated cloud connection.
4. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.
5. Device shall have a standard and astronomical internal time clock.
6. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x Wireless and IEEE 802.3 Wired connection.
7. System Controller shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.

a. BACnet/MSTP shall support a minimum of 50 additional BACnet MS/TP controllers in addition to the Expansion I/O modules.
b. BACnet/MSTP shall support 9600 to 115200 baud.
c. System Controller shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
d. System controller must support BACnet/IP Broadcast Management Device (BBMD) and Foreign Device Registration (FDR).

B. OpenADR Interface
1. System shall provide an interface to OpenADR protocol Demand Response Automation Servers (DRAS) typically provided by local electrical utility.
2. OpenADR interface shall meet all of the requirements of Open ADR 2.0a Virtual End Nodes (VEN), including:
a. Programmable with the account information of the end-user's electrical utility DRAS account credentials.

2.5 WIRED NETWORKED DEVICES

A. Wired Networked Wall Switches, Dimmers, Scene Controllers
1. Wall switches & dimmers shall support the following device options:
a. Number of control zones: 1, 2 or 4. Gang multiple switches where more than 4 control zones are required in a single location under a single faceplate.
b. Control Types Supported: On/Off or On/Off/Dimming
2. Scene controllers shall support the following device options:
a. Number of scenes: 1, 2 or 4
b. Control Types Supported:
1) On/Off or On/Off/Dimming
2) Preset Level Scene Type
3) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene
4) Selecting a lighting profile to be run by the system's upstream controller to implement a selected lighting profile across multiple zones
3. Match color specified in Division26 Section " Wiring Devices."
4. Integral green LED pilot light to indicate when circuit is on.
5. Internal white LED locator light to illuminate when circuit is off.
6. Networked switch stations shall have backlit buttons.
7. Wall Plates:
a. Single and multigang plates as specified in Division 26 Section "Wiring Devices."
b. Where multiple switches and/or dimmers are adjacent to each other, install a single cover plate. Provide separate boxes or barriers as required for the application.
c. Provide cover plates that are identical in material and dimension to standard single and double gang switch plates.
d. Verify back box requirements for multiple control points with manufacturer.
8. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

B. Wired Networked Graphic Wall Stations
1. Device shall have a full color touch screen.
2. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
3. Graphic wall stations shall support the following device options:
a. Number of control zones: Minimum of 16
b. Number of scenes: Minimum of 16
c. Optional password protection for setup screens.

C. Wired Networked Auxiliary Input / Output (I/O) Devices

1. Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:
    a. Contact closure input: Programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, ramp light level up or down, or toggle lights on/off.
    b. 0-10V analog input: Programmable to function as a daylight sensor.
    c. RS-232/RS-485 digital input: Supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
    d. 0-10V dimming control output, capable of sinking a minimum of 20mA of current programmable to support all standard sequence of operations supported by system.

D. Wired Networked Occupancy and Photosensors
1. Sensors shall utilize passive infrared (PIR) or passive dual technology (PDT) to detect both major and minor motion as defined by NEMA WD-7 standard.
2. Sensing technologies that are acoustically passive, meaning they do not transmit sounds waves of any frequency do not require additional commissioning. Ultrasonic or Microwave based sensing technologies may require commissioning due to the active nature of their technology, if factory required.
3. Provide sensors with a bypass switch to override the “ON” function in the event of sensor failure.
4. Provide sensors with an LED indicator indicating when motion is being detected during testing and normal operation of the sensor.
5. All occupancy sensors shall be programmed as manual ON.
6. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device.
7. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 15 minutes.
8. Sensor Orientation: Orient sensor in room such that sensor will not detect motion through open door which could cause false activation.
9. Adjust occupancy sensors and test that complete minor motion coverage is obtained in accordance with Part 3. Provide written confirmation of testing to owner, architect and engineer.
10. Sensor mounting type shall match project design requirements as shown on plans.
    a. Sensors shall have optional features for photosensor/daylight override, dimming control, and low temperature/high humidity operation.
11. The system shall support the following types of photocell-based control:
    a. On/Off: The control zone is automatically turned off if the photocell reading exceeds the defined setpoint and automatically turned on if the photocell reading is below the defined setpoint. A time delay or adaptive setpoint adjustable behavior may be used to prevent the system from exhibiting nuisance on/off switching.
    b. Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.
    c. Fade Rate: The rate of change in the light output of the control zone shall be adjustable.

E. Wired Networked Wall Switch Sensors
1. Wall switches sensors shall support the following device options:
    a. User Input Control Types Supported: On/Off or On/Off/Dimming
    b. Occupancy Sensing Technology: PIR only or Dual Tech

c. Daylight Sensing Option: Inhibit Photosensor

F. Wired Networked Embedded Sensors
   1. Embedded sensors shall support the following device options:
      a. Occupancy Sensing technology: PIR only or Dual Tech
      b. Daylight Sensing Option: Occupancy only, Daylight only, or combination Occupancy/Daylight sensor

G. Distributed System Power, Switching and Dimming Controls
   1. Devices shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
   2. Device programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
   3. Device shall be plenum rated.
   4. Devices shall be UL Listed for load and load type as specified on the plans.

H. Wired Networked Luminaires
   1. Networked luminaire shall have a factory installed mechanically integrated control device and carry a UL Listing as required.
   2. Networked LED luminaire shall provide low voltage power to other networked control devices.
   3. System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by automatically varying the dimming control signal to account for lumen depreciation.
   4. System shall be able to provide control of network luminaire intensity, in addition to correlated color temperature of specific LED luminaires.
   5. Controls manufacturer is responsible for primary troubleshooting and tech support of complete fixture.

I. Wired Networked Relay and Dimming Panel
   1. Relay and dimming panel(s) shall be capable of providing the required amount of relay capacity, as required per panel schedules shown on drawings, with an equal number of individual 0-10V dimming outputs.
   2. Standard relays used shall have the following required properties:
      a. Configurable in the field to operate with normally closed or normally open behavior.
      b. Provides visual status of current state and manual override control of each relay.
      c. Be individually programmable
   3. 0-10 dimming outputs shall support a minimum of 100mA sink current per output.
   4. Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205)
   5. Cabinet: Steel with hinged, locking door or flush, surface mounted cover attached with screws.
      a. Barriers separate low-voltage and line-voltage components.
      b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device, if any.
      c. User interface panel: Accessible without removing cover.
   6. Relays: Mechanically held; split-coil, momentary-pulsed type.
      a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
      b. Rated Capacity (Mounted in Relay Panel): 20 A for any load type at 277V or 120V.
      c. Endurance: 1,000,000 cycles at rated capacity.
      d. Mounting: Provision for easy removal and installation in relay cabinet.
   7. Panel shall be UL924 listed for control of emergency lighting circuits.
   8. Panel shall provide a contact closure input that acts as a panel override to activate the normally configured state of all relays (i.e., normally open or normally closed) in the panel.

2.6 WIRELESS NETWORKED DEVICES

A. Wireless Networked Sensor Interface
   1. The device shall be capable of broadcasting the following manual wall control commands: on, off, and adjust dim level.
B. Wireless Networked Light Controllers (No Sensor)
   1. The wireless light controller shall be capable of providing continuous dimming and on/off control of one commercial light fixture including fluorescent, HID, induction and LEDs.
   2. An external antenna attached to the luminaire shall not be allowed.
      a. Each wireless light controller shall provide measurement capability of the amperage, voltage, wattage, and watt-hours of its controlled lighting.
C. Wireless Networked Digital Sensors
   1. In addition to providing Wireless Networked Light Controllers functionality, also provides:
      a. Integrated digital occupancy sensing and digital photocell sensor.
      b. Sensor shall connect directly to the wireless light controller and shall be suitable for embedding into the enclosure of a luminaire.
      c. Sensor shall have software-adjustable settings
      d. Photocell shall be suitable for closed and open loop applications.
D. Wireless Network Communication Bridge
   1. A communication bridge device shall be provided that interfaces with the System Controller via Owner's LAN connection and interfaces with wireless network.
   2. Device shall be capable of communicating with a group of a minimum of 250 wireless networked devices and luminaires, so as to reduce the amount of communication bridges required in the system.

2.7 CONDUCTORS AND CABLES

A. General: All conductors and cables shall comply with the requirements of Division 26 Section "Conductors and Cables." Where cable is permitted to be installed exposed in ceiling space, provide plenum rated cable.
B. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG.
C. Classes 2 and 3 Control Cables: Multi-conductor cable with copper conductors not smaller than No. 22 AWG.
D. Class 1 Control Cables: Multi-conductor cable with copper conductors not smaller than No. 18 AWG.
E. Digital and Multiplexed Signal Cables: As required by system manufacturer. Provide plenum rated cables where installed exposed in ceiling space.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. The lighting control system shall be installed and connected as shown on the plans and as directed by the manufacturer.
B. Comply with NECA 1.
C. Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Comply with Division 26 Sections "Conductors and Cables" and "Raceways and Boxes".
D. Where cables are installed in finished areas with exposed construction, conceal cables from view. Route at top of structural systems and conceal on top of structural members where possible. Where cable is exposed to view, provide raceway. As an alternative to raceway, provide cable that is factory colored to match exposed ceiling. Submit sample to Architect for approval.

E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
F. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
G. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
H. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes as per manufacturers' recommendations.
I. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."
J. Label each relay with a unique designation.

3.2 OCCUPANCY SENSOR INSTALLATION

A. Install wall mounted occupancy sensors as noted on plan. Arrange occupancy sensors with adjacent switch devices so that device plates line-up and are equally spaced.
B. Install ceiling mounted sensors at approximate locations as indicated on plan. Sensor manufacturer shall provide quantity of sensors as required to provide complete coverage for rooms.
C. Locate sensors such that motion through open doors or glass will not falsely activate sensors.
D. Do not locate ultrasonic sensors within six feet of supply air diffusers.
E. Locate infrared sensors to avoid obstructions.
F. Provide the services of a manufacturer's representative for commissioning of occupancy sensor installation. This shall include consultation on layout and location prior to installing sensors, testing of each sensor for compliance with Contract Documents and field adjustment and fine tuning after installation is complete. Provide written confirmation of testing to the Owner, Architect and Engineer.
G. Field adjustments shall take place in the presence of the owner and the engineer. This shall include owner training on adjustment techniques for the occupancy sensors.

3.3 INSTALLATION REQUIREMENTS

A. Review all required installation and pre-startup procedures with the manufacturer's representative through pre-construction meetings.
B. Install and connect the networked lighting control system components according to the manufacturer's installation instructions, wiring diagrams, the project submittals, plans and specifications.
C. Coordination with Owner's IT Network Infrastructure to secure all required network connections to the owner's IT network infrastructure. Provide the owner's representative with all network infrastructure requirements of the networked lighting control system. Provide the manufacturer's representative with all necessary contacts pertaining to the owner's IT infrastructure, to ensure that the system is properly connected and started up.
D. Verify integration and interoperability scope with the Mechanical Contractor prior to submittal phase and provide all necessary schedules to the Lighting Control manufacturer.

3.4 SYSTEM STARTUP

A. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed by an authorized representative of the manufacturer.
   1. Low voltage network cable testing shall be performed prior to system startup at the discretion of the manufacturer.
B. System start-up and programming shall include:
   1. Verifying operational communication to all system devices.
   2. Programming the network devices into functional control zones to meet the required sequence of operation.
   3. Programming and verifying all sequence of operations.
   4. Customization of owner's software interfaces and applications.
C. Initial start-up and programming is to occur on-site. Additional programming may occur on-site or remotely over the Internet as necessary.

3.5 DOCUMENTATION

A. Submit software database file with desired device labels and notes completed.
B. Document the installed location of all networked devices, including networked luminaires. Provide as-built plan drawing showing device addresses corresponding to locations of installed equipment.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components and equipment installation, including connections and assist in field testing. Report results in writing.
B. Perform the following field tests and inspections and prepare test reports:
   1. Test for circuit continuity.
   2. Verify that the control module features are operational.
   3. Check operation of local override controls.
   4. Test system diagnostics by simulating improper operation of several components selected by Architect.

3.7 SYSTEM COMMISSIONING

A. Facilitate the functional testing and verification of the lighting control system by an independent, third party commissioning agent.
B. Perform commissioning in the presence of the Owner's representative.
C. Submit functional test plan checklist signed by the commissioning agent.

3.8 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.9 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting programming functions and other system parameters and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to program, adjust, operate, and maintain lighting controls.
B. Demonstration shall be done only after initial system start-up setup has occurred and system is functioning properly.
C. Demonstration shall consist of a four hour minimum session.

3.11 MANUFACTURER SUPPORT

A. Manufacturer telephone support shall be available at no cost to the Owner during the warranty period and shall include the following:
   1. Assistance in solving programming or other application issues pertaining to the control equipment.
   2. The manufacturer shall provide a toll-free number for direct technical support available 7 days a week, 24 hours a day.
   3. A factory authorized technician shall be located within a 100 mile radius of the project site.

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SECTION 26 0999
ELECTRICAL TESTING

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 of this section.

B. Related Sections include the following:
   1. Division 26 Section “Electrical General Requirements.”
   2. Division 26 Section “Conductors and Cables.”
   3. Division 26 Section “Grounding and Bonding.”
   4. Division 26 Section “Electrical Power Monitoring and Control.”
   5. Division 26 Section “Medium-Voltage Transformers.”
   6. Division 26 Section “Enclosed Controllers.”
   7. Division 26 Section “Surge Protective Devices”
   8. Division 26 Section “Switchgear.”
   9. Division 26 Section “Switchboards.”
   10. Division 26 Section “Panelboards.”
   11. Division 26 Section “Dry Type Transformers (600V and Less).”
   12. Division 26 Section “Enclosed Bus Assemblies.”
   13. Division 26 Section “Fuses.”

1.2 SECTION INCLUDES

A. The Electrical Contractor shall engage the services of a recognized corporately independent N.E.T.A. certified testing firm for the purpose of performing inspections and tests as herein specified

B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

C. It is the intent of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design Specifications.

D. The test and inspections shall determine suitability for energization.

E. Equipment to be tested and inspected shall be the equipment shown on the one line diagram and schedules as required by part three of each individual Specification Section.

F. Test and inspect existing medium voltage air interrupter switches, switchboards and distribution panels that are affected by the scope of work.

1.3 REFERENCES

A. All inspections and tests shall be in accordance with the latest version of the following codes and standards except as provided otherwise herein.
   1. National Electrical Manufacturer's Association - NEMA
   2. American Society for Testing and Materials - ASTM
   3. Institute of Electrical and Electronic Engineers - IEEE
   4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1996
   5. InterNational Electrical Testing Association - NETA Maintenance Testing Specifications-MTS-1997
   6. American National Standards Institute - ANSI C2: National Electrical Safety Code
   7. State and Local Codes and Ordinances
   8. Insulated Cable Engineers Association - ICEA
   9. Association of Edison Illuminating Companies - AEIC
   10. Occupational Safety and Health Administration
   11. National Fire Protection Association - NFPA
      a. ANSI/NFPA 70: National Electrical Code
      b. ANSI/NFPA 70B: Electrical Equipment Maintenance
      c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
      d. ANSI/NFPA 101: Life Safety Code

1.4 QUALIFICATIONS

A. The testing firm shall be a corporately independent testing organization, which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
C. The lead, on site, technical person and at least 50% of the on site crew shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies in Electrical Power Distribution System Testing.
D. The testing firm shall only utilize technicians who are regularly employed by the firm on a full-time basis for testing services.
E. The Contractor shall submit proof of the above qualifications with bid proposal.
F. The terms used herewithin such as Test Agency, Test Contractor, Testing Laboratory, or Contractor Test Company, shall be construed to mean the testing organization.
G. Acceptable Testing Firms:
   1. Northern Electrical Testing; Phone (248) 689-8980.
   2. Utilities Instrumentation Services; Phone (734) 424-1200.
   3. Emerson/High Voltage Maintenance Corporation; Phone (248) 305-5596.
   4. Power Plus Engineering, Inc. Phone (248) 344-0200.

1.5 PERFORMANCE REQUIREMENTS

A. The Electrical Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the power requirements.
B. The Electrical Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.
C. The testing firm shall notify the Owner's Representative prior to commencement of any testing.
D. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported to the Engineer. The Electrical Contractor shall correct all defects.

E. The testing organization shall maintain a written record of all tests and shall assemble and certify a final test report.
F. Safety and Precautions
   1. Safety practices shall include, but are not limited to, the following requirements:
      a. Occupational Safety and Health Act.
      b. Accident Prevention Manual for Industrial Operations, National Safety Council.
      c. Applicable state and local safety operating procedures.
      d. NETA Safety/Accident Prevention Program.
      e. Owner's safety practices.
      f. National Fire Protection Association - NFPA 70E.
      g. American National Standards for Personnel Protection.
   2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
   3. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

1.6 TEST INSTRUMENT CALIBRATION

A. Test Instrument Calibration
   1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy.
   2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
   3. Instruments shall be calibrated in accordance with the following frequency schedule:
      a. Field instruments: Analog - 6 months maximum Digital - 12 months maximum
      b. Laboratory instruments: 12 months
      c. Leased specialty equipment: 12 months
      (Where accuracy is guaranteed by Lessor)
   4. Dated calibration labels shall be visible on all test equipment.
   5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
   6. An up-to-date instrument calibration instruction and procedures shall be maintained for each test instrument.
   7. Calibrating standard shall be of higher accuracy than that of the instrument tested.
B. Field Test Instrument Standards
   1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
      a. Maintained in good visual and mechanical condition.
      b. Maintained in safe, operating condition.
C. Suitability of Test Equipment
   1. All test equipment shall be in good mechanical and electrical condition.
   2. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multi-meters may be average of RMS sensing and may include or exclude the dc component. When the variable contains harmonics of dc offset and, in general, any deviation from a pure sine wave, average sensing, average measuring RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.
   3. Field test metering used to check power system meter calibration must have any accuracy higher than that of the instrument being checked.
   4. Accuracy of metering in test equipment shall be appropriate for the test being performed.
   5. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

1.7 SUBMITTALS

A. A test report shall be generated for each piece of major equipment or groups of equipment and shall include the following:
   1. A list of visual and mechanical inspections required by Division 26 Specification Sections in a checklist or similar format.
   2. Test reports, including test values where applicable, for all required electrical tests. Clearly indicate where test values fall outside of the limits of recommended values.
   3. Summary and interpretation of test results detailing problems located and recommended corrective measures.
   4. Record of infrared scan and photos showing potential problem locations.
   5. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.

B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 EXISITING AIR INTERRUPTER SWITCHES

A. Testing: Perform the complete maintenance testing on two existing medium voltage air interrupter switches as required in NETA-MTS section 7.5.1.2, including but not limited to the following:
   1. Visual and Mechanical Inspection
      a. Inspect for physical, electrical and mechanical condition.
      b. Compare equipment nameplate information with construction document one line diagram and report discrepancies.
      c. Check for proper anchorage, required area clearances, physical damage, and proper alignment.
      d. Inspect all bus connections for high resistance by infrared survey after equipment has been energized.
      e. Test all electrical and mechanical interlock systems for proper operation and sequencing.
         1) Closure attempt shall be made on locked open devices. Opening attempt shall be made on locked closed devices.
      f. Inspect accessible insulators for evidence of physical damage or contaminated surfaces.
      g. Verify that fuse and/or circuit breaker sizes and types correspond to Drawings.
      h. Verify proper ground connection to ground mat.

   2. Electrical Tests
      a. Perform insulation resistance tests on each bus section, phase-to-phase and phase-to-ground for one (1) minute.
      b. Determine accuracy of volt and amp readings for all meters and verify multipliers

B. Test Values

1. Insulation resistance test to be performed in accordance with N.E.T.A. Maintenance Testing Specifications, Table 100.1. Values of insulation resistance less than manufacturer's minimum should be investigated.

C. Report test results in writing.
D. Remove and replace malfunctioning units and retest as specified above.

3.2 THERMOGRAPHIC SURVEY

A. Visual and Mechanical Inspection
   1. Remove all necessary covers prior to scanning.
   2. Inspect for physical, electrical, and mechanical condition.
B. Equipment to be Scanned
   1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.
C. Provide report indicating the following:
   1. Problem area (location of "hot spot").
   2. Temperature rise between "hot spot" and normal or reference area.
   3. Cause of heat rise.
   4. Phase unbalance, if present.
   5. Areas scanned.
D. Test Parameters
   1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
   2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
   3. Infrared surveys should be performed during periods of maximum possible loading but not less than twenty percent (20%) of rated load of the electrical equipment being inspected.
E. Test Results
   1. Interpretation of temperature gradients requires an experienced technician. Some general guidelines are:
      a. Temperature gradients of 37°F to 44.6°F indicate possible deficiency and warrant investigation.
      b. Temperature gradients of 37°f to 59°F indicate deficiency; repair as time permits.
      c. Temperature gradients of 61°F and above indicate major deficiency; repair immediately.

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SECTION 26 1200
MEDIUM-VOLTAGE TRANSFORMERS

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 transformers with medium-voltage primaries:
   1. Liquid-filled distribution and power transformers.
B. Related Sections:
   1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, utility or manufacturer’s anchorage and base recommendations, containment pan, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.
B. Field quality-control test reports.
C. Follow-up service reports.
D. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers 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. Comply with IEEE C2.
D. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.
E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.7 PROJECT CONDITIONS

A. Service Conditions: IEEE C37.121, usual service conditions.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”
B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

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. Cooper Industries; Cooper Power Systems Division.
   3. Cutler-Hammer.
   4. GE Electrical Distribution & Control.
   5. Siemens Industries, Inc.
   6. Square D; Schneider Electric.

2.2 LIQUID-FILLED DISTRIBUTION AND POWER TRANSFORMERS

A. Description: IEEE C57.12.00 and UL 1062, liquid-filled, 2-winding transformers.
B. Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
C. Insulation Temperature Rise: Based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C.
   1. Provide transformers with base kVA 55 deg C, 65 deg C, 75 deg C or dual rated with 55/65, 65/75 or 55/75 deg C rise. Temperature rise and kVA ratings including dual ratings, if specified, shall be as indicated on one-line diagrams.
D. Basic Impulse Level: Comply with UL 1062.
E. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

F. Cooling System: Class KNAN, self-cooled. Cooling systems shall include auxiliary cooling equipment, automatic controls, and status indicating lights.
G. Impedance: 5.75 percent.
H. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
   1. Liquid-level gage.
   2. Pressure-vacuum gage.
   3. Liquid temperature indicator.
   4. Drain and filter valves.
   5. Pressure relief device.
   6. Integral steel containment pan providing 100% fluid containment.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Electrical Identification."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90.
B. Factory Tests: Perform the following factory-certified tests on each transformer:
   1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
   2. Ratios on rated-voltage connection and on tap extreme connections.
   3. Polarity and phase relation on rated-voltage connection.
   4. No-load loss at rated voltage on rated-voltage connection.
   5. Excitation current at rated voltage on rated-voltage connection.
   6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
   7. Applied potential.
   8. Induced potential.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.
B. Examine roughing-in of conduits and grounding systems to verify the following:
   1. Wiring entries comply with layout requirements.
   2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
C. Examine walls, floors, and concrete bases for suitable mounting conditions where transformers will be installed.
D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding" 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. Install transformers and anchor to concrete bases according to utility or manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."
B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”
B. Visual and Mechanical Inspection
   1. Compare equipment nameplate information with single line diagram.
   2. Inspect for physical damage, cracked insulators, leaks, tightness of connections, and general mechanical and electrical conditions.
   3. Verify proper auxiliary device operation.
   4. Verify proper liquid level in all tanks and bushings.
   5. Perform specific inspections and mechanical tests as recommended by manufacturer.
   6. Verify proper equipment grounding.
   7. Verify removal of any shipping bracing after final placement.
C. Electrical Tests
   1. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a meg-ohmmeter with test voltage output as shown in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Test duration shall be for 10 minutes with resistence values tabulated at 30 seconds, 1 minute, and 10 minutes. Calculate Polarization index.
   2. Perform a turns ratio test between windings at all tap positions. The final tap setting is to be set at the secondary system rated voltage at full load or as directed by the Architect/Engineer.
   3. Insulating liquid shall be sampled in accordance with ASTM D-923. Sample shall be laboratory tested for:
      a. Dielectric breakdown voltage: ASTM D-877 or ASTM D-1816
      b. Acid neutralization number: ASTM D-974
      c. Interfacial tension: ASTM D-971 or ASTM D-2285
      d. Color: ASTM D-1500
      e. Visual Condition: ASTM D-1524
      f. Perform dissolved gas analysis (DGA) in accordance with ANSI/IEEE C57.104 or ASTM D-3612 for transformers 500 kVA and larger.
   4. Perform insulation power factor tests or dissipation factor tests on all windings and bushings. Overall dielectric-loss and power factor (C_H, C_L, C_{HL}) shall be determined. Test voltages should be limited to the line to ground voltage rating of the transformer winding.
   5. Perform tests and adjustments on tap-changer, fan and pump controls, and alarm function.
   6. Verify proper core grounding if accessible.
   7. Perform percent oxygen test on the nitrogen gas blanket for 3000 kVA or larger.
D. Test Values
   1. Perform insulation resistance tests in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Results to be temperature corrected in accordance with Table 10.14.
   2. The polarization index should be used for future reference.

3. Turns ratio test results shall not deviate more than one half percent (0.5%) from either the adjacent coils or the calculated ratio.
4. Maximum power factor of liquid filled transformers corrected to 20°C shall be in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.3.
5. Bushing power factors and capacitances that vary from nameplate values by more than ten percent (10%) should be investigated.
6. Dielectric fluid should comply with N.E.T.A. Acceptance Testing Specifications, Table 10.4.

E. Remove and replace malfunctioning units and retest as specified above.

F. Test Reports: Prepare written reports 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 actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: Perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:
1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
   a. Adjust transformer taps.
   b. Prepare written request for voltage adjustment by electric utility.
3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
4. Report: Prepare written report covering monitoring and corrective actions performed.

END OF SECTION 26 1200

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SECTION 26 2413
SWITCHBOARDS

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 service and distribution switchboards rated 600 V and less.
B. Related Sections:
   1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. RFI: Radio-frequency interference.
D. RMS: Root mean square.
E. SPDT: Single pole, double throw.

1.4 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, utility or manufacturer’s anchorage and base

recommendations, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Related Submittals:
   1. Provide overcurrent device coordination study to demonstrate proper overcurrent device ratings, adjustments, and settings.

C. Shop Drawings: For each switchboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1.
      b. Bus configuration, current, and voltage ratings.
      c. Short-circuit current rating of switchboards and overcurrent protective devices.
      d. Descriptive documentation of optional barriers specified for electrical insulation and isolation if specified.
      e. Utility company's metering provisions with indication of approval by utility company if called out.
      f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   2. Wiring Diagrams: Power, signal, and control wiring.

D. Field quality-control test reports including the following:
   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.

E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, 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.
   3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

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 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. Source Limitations: Obtain switchboards through one source from a 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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."

F. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections or lengths that can be moved past obstructions in delivery path.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
C. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.7 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: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: Not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.
C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Construction Manager's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components 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 size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

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 MANUFACTURED UNITS

A. Manufacturers:
   1. Eaton Corporation; Cutler-Hammer Products.
   2. General Electric Co.; Electrical Distribution & Protection Div.
   3. Siemens Industries, Inc.
   4. Square D.
B. Front-Connected, Front-Accessible Switchboard:
   1. Main devices over 1200A: Fixed, individually mounted.
   2. Main devices below 1200A, panel mounted.
   3. Branch Devices: panel-mounted.
   4. Sections rear aligned.
C. Nominal System Voltage: As noted on Drawings.
D. Main-Bus Continuous: As noted on Drawings.
E. Enclosure: Steel, NEMA 250, Type 1 not over 102 in height.

F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
G. Insulation and isolation for main and vertical buses of feeder sections.
H. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
I. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
J. Buses and Connections: Three phase, four wire, unless otherwise indicated.
    1. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with copper- or tin-plated, aluminum circuit-breaker line connections.
        a. If bus is aluminum, use copper- or tin-plated aluminum for circuit-breaker line connections.
    2. Ground Bus: 1/4-by-2-inch- minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
    3. Contact Surfaces of Buses: Silver plated.
    4. Main Phase Buses, Neutral 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. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
    6. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.
K. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.3 SURGE PROTECTIVE DEVICES

A. Direct bus connected type as specified in Division 16 26 Section "Surge Protective Devices."
B. Provide Surge Protective Device for switchboards where indicated on the drawings.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, 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.
        a. Circuit Breakers 250A and Larger: Magnetic trip element with front-mounted, field-adjustable trip setting with restricted access cover.
    2. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings with restricted access cover:
        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.
B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
    1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    2. Application Listing: Appropriate for application; Type HACR for heating, air-conditioning, and refrigerating equipment.
    3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system, specified in Division 26 Section "Electrical Power Monitoring and Control."
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

C. Circuit breaker selection for transformer primary protection:
1. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

D. Circuit breakers rated 1200A and above:
1. Circuit breakers rated 1200A and above, not specified elsewhere with zone selective interlocking, shall be provided with an energy reducing maintenance switch with local status indicator.
2. The switch and status indicators shall be remote from the circuit breaker, located at the entrance to the electrical room where the circuit breaker is installed.

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

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. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.6 CONTROL POWER

A. Control Circuits: 120 V, 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.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
B. Provide permanent provisions for locking all overcurrent devices in switchboard. Provisions shall remain in place whether or not lock is installed.
C. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 EXAMINATION

A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.
B. Install switchboards and anchor to concrete bases according to utility or manufacturer’s recommendations, seismic codes at Project, and requirements in Division 26 Section “Hangers and Supports for Electrical Systems.”
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 overcurrent protective devices, transient voltage suppression devices, and instrumentation.
    1. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 ADJUSTING

A. Adjust circuit breaker trip and time delay settings to values as instructed by the Engineer.

3.5 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
    1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
    2. Test continuity of each circuit.
B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing.”
    1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. 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 switchboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Instruments, Equipment, and Reports:
      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      2) Prepare 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.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 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.

END OF SECTION 26 2413

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SECTION 26 2416
PANELBOARDS

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. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.
B. Related Sections:
   1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. GFEP: Ground-fault equipment protection.
D. AFCI: Arc-fault circuit interrupter.
E. RFI: Radio-frequency interference.
F. RMS: Root mean square.
G. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, surge protective device, accessory, and component indicated. Include dimensions and

manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Related Submittals:
   1. Provide overcurrent device coordination study to demonstrate proper overcurrent device ratings, adjustments, and settings.

C. Shop Drawings: For each panelboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1.
      b. Bus configuration, current, and voltage ratings.
      c. Short-circuit current rating of panelboards and overcurrent protective devices.
      d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
      e. Nameplate engraving.
   2. Wiring Diagrams: Power, signal, and control wiring.
   3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports including the following:
   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.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, 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.

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 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.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

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 PB 1.

F. 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 exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

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. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
a. Eaton Corporation; Cutler-Hammer Products.
b. GE by ABB.
c. Siemens Industries, Inc.
d. Square D.

2.2 MANUFACTURED UNITS

A. Enclosures: Mounting as noted on panel schedules. NEMA PB 1, Type 1.
1. Cabinet Front: Flush or surface cabinet as noted on the Drawings.
a. Eaton – LT Trim with Door in Door Design, piano hinge on outer door.
b. Siemens – Figure 4 hinge to box w/piano hinge.
c. GE – FGB (front hinge to box).
d. Square D – Continuous piano hinge trim.
2. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
3. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

B. Phase and Ground Buses:
1. Material: Aluminum
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

C. Conductor Connectors: Suitable for use with conductor material.
1. Main and Neutral Lugs: Mechanical type.

2. Ground Lugs and Bus Configured Terminators: Compression type.
3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Double Lugs: Mechanical type mounted at location of main incoming lugs.

D. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

E. Surge Protective Devices: Where indicated, provide manufactured units with direct bus connected type as specified in Division 26 Section "Surge Protective Devices."
1. Provide Surge Protective Devices where indicated on the drawings.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS

A. Main bus bars, neutral and ground, shall be aluminum and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

C. Main Overcurrent Protective Devices: Circuit breaker.

D. Branch Overcurrent Protective Devices:
1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Main bus bars, neutral and ground, shall be sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

C. Circuit breakers used for feeding electrical heat tracing shall include ground fault equipment protection rated to trip at 30 ma.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, 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.
a. Circuit Breakers 250A and Larger: Magnetic trip element with front-mounted, field-adjustable trip setting with restricted access cover.
2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
3. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
5. Shunt Trip: 120-V trip coil energized from separate circuit.
6. Do not use tandem circuit breakers.
7. Provide lock on devices for circuit breakers when called out on panel schedules with “LOD” designation.
8. Provide type GFEP circuit breakers for all self- regulating heating (snow melting and heat trace) cables branch circuits and where noted on panel schedules with “GFEP” designation
9. Provide GFCI circuit breaker when called out on panel schedules with “GFCI” designation.
10. Provide Arc-Fault Circuit Interrupters where indicated on panel schedule with “AFCI” designation.
11. Provide shunt trip breakers when called out on panel schedules with “STB” designation.
12. Provide permanent padlockable handle for circuit breakers when called out on panel schedules with “PL” designation.

C. Circuit Breaker Selection for Transformer Primary Protection:
1. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

D. Circuit breakers rated 1200A and above:
1. Circuit breakers rated 1200A and above, not specified elsewhere with zone selective interlocking, shall be provided with an energy reducing maintenance switch with local status indicator.
2. The switch and status indicators shall be remote from the circuit breaker, located at the entrance to the electrical room where the circuit breaker is installed.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
B. Provide permanent provisions for padlocking all overcurrent devices in Distribution Panelboards. Provisions shall remain in place whether or not lock is installed.
C. Provide permanent provisions for padlocking overcurrent devices in Branch Circuit Panelboards that serve equipment not provided with a local, lockable disconnecting means. Provisions shall remain in place whether or not lock is installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.
B. Comply with mounting and anchoring requirements specified in Division 26 Section “Hangers and Supports for Electrical Systems.”
C. Mount top of trim 74 inches above finished floor, unless otherwise indicated.
D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
E. Install overcurrent protective devices and controllers.
1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install filler plates in unused spaces.
G. Stub four 1-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
I. Color code circuit breakers of fire alarm systems with red paint. Provide lock-on clips on the circuit breaker handles.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
B. Create a directory to indicate installed circuit loads after balancing panelboard loads or created by retrofitting. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Coordinate final directory room names and numbers with Owner.
C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

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. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters. Perform electrical tests on all breakers and switches 200A and above or that constitute a component of an emergency distribution system. Main circuit breakers in branch circuit panelboards 225A and below are not required to be tested.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
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.
D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints 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 panelboards checked and describes scanning results. Include notation of

deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 2416

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SECTION 26 2500
ENCLOSED BUS ASSEMBLIES

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. Plug-in bus assemblies.
   2. Bus plug-in devices.

1.3 DEFINITIONS

A. SPD: Surge Protective Device.

1.4 SUBMITTALS

A. Product Data: Include technical descriptions, dimensions, rated capacities, weights, finishes, and accessories for the following:
   1. Plug-in bus assemblies.
   2. Bus plug-in devices.
B. Shop Drawings: For each type of bus assembly and plug-in device.
   1. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, fire stops, weather stops, straight lengths, and fittings.
   2. Indicate required clearances, method of field assembly, and location and size of each field connection.
   3. Detail connections to switchgear, switchboards, transformers, and panelboards.

C. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements. Show the following:
   1. Horizontal enclosed bus-assembly runs, offsets, and transitions.
   2. Clearances for access above and to the side of enclosed bus assemblies.
   3. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
   4. Support locations, type of support, and weight on each support.
   5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For enclosed bus assemblies to include in emergency, operation, and maintenance manuals.

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 or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
B. Source Limitations: Obtain enclosed bus assemblies and plug-in devices through one source from a single manufacturer.
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. Comply with NEMA BU 1, "Busways."
E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Proper Handling, Installation, Operation and Maintenance of Busway Rated 600 Volts or Less."

1.7 COORDINATION

A. Coordinate layout and installation of enclosed bus assemblies and suspension system with other construction that penetrates ceilings or floors or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

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. Hook-stick operator for plug-in units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Corp.--Cutler-Hammer Products

2. GE by ABB
3. Siemens Industries, Inc
4. Square D

2.2 ENCLOSED BUS ASSEMBLIES

A. Plug-in Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing, single-bolt joints, ratings as indicated.

1. Voltage: 208/120V or 480/277V; 3 phase; as indicated on plan.
2. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
3. Bus Materials: Current-carrying aluminum conductors, fully insulated with Class 130C insulation except at stabs and joints; plated surface at stabs and joints.
4. Ground:
   a. 50 percent capacity internal busbar of material matching bus material.
5. Enclosure: Steel, with manufacturer's standard enamel finish, plug-in openings on both sides, 24 inches on center, and hinged covers over unused openings
6. Fittings and Accessories: Manufacturer's standard.

2.3 PLUG-IN DEVICES

A. Fusible Switches: NEMA KS 1, heavy duty; with rejection-type fuse clips to accommodate specified fuses; hook-stick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. See Division 26 Section "Fuses" for fuses and fuse installation requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.
   1. Design each fastener and support to carry 200 lb or 4 times the weight of bus assembly, whichever is greater.
   2. Support bus assembly to prevent twisting from eccentric loading.
   3. Support bus assembly with not less than 3/8-inch steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
   4. Fasten supports securely to building structure according to Division 26 Section "Basic Electrical Materials and Methods."
B. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed 90 percent of manufacturer's recommended distance between fittings.
C. Install firestop fittings where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings. Seal around penetrations according to Division 7 Section "Through-Penetration Fire-Stop Systems," and as directed by authorities having jurisdiction.
D. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.
E. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.
F. Install bus-assembly plug-in units. Support connecting conduit independent of plug-in unit.

3.2 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."
B. Connect wiring according to Division 26 Section "Conductors and Cables."
C. 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. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”
B. Visual and Mechanical Inspection
    1. Inspect bus for physical damage and proper connection in accordance with single line diagram.
    2. Inspect for proper bracing, suspension alignment, and enclosure ground.
    3. Check tightness of bolted joints by infrared survey.
    4. Check for proper physical orientation per manufacturer's labels to ensure proper cooling. Perform continuity tests on each conductor to verify that proper phase relationships exist.
C. Electrical Tests
    1. Measure insulation resistance of each bus run phase-to-phase and phase-to-ground for one (1) minute.
    2. Perform phasing test on each bus tie section energized by separate sources. Test must be performed from their permanent sources.
D. Test Values
    1. Insulation resistance test voltages and resistance values to be in accordance with manufacturer's Specifications.
E. Remove and replace units that do not pass tests or inspections and retest as specified above.

3.4 ADJUSTING

A. Set field-adjustable, circuit-breaker trip ranges and overload relay trip settings as indicated.

3.5 CLEANING

A. After completing system installation, clean enclosed bus assemblies, supports, and accessories. Inspect exposed finishes and repair damaged finishes. Remove scratches, burrs, and surface defects.

3.6 PROTECTION

A. Provide final protection to ensure that moisture does not enter bus assembly.

END OF SECTION 26 2500

SECTION 26 2713
ELECTRICITY METERING

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 equipment for electricity metering by Owner.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe electrical characteristics, features, and operating sequences, both automatic and manual. Include the following:
   1. Electricity-metering equipment.
B. Shop Drawings for Electricity-Metering Equipment:
   1. Dimensioned plans and sections or elevation layouts.
   2. Wiring Diagrams: Power, signal, and control wiring specific to this Project. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For electricity-metering equipment to include in emergency, 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.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.6 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
   1. Comply with requirements of utilities providing electrical power and communication services.
   2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   1. E-MON L.P.
   2. National Meter Industries, Inc.
   3. Osaki Meter Sales, Inc.
   4. Power Measurement.
   5. Square D; Schneider Electric.

B. Kilowatt-Hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand.
   1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
   2. Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.
   3. Programmable Contact Module: Unit shall have push-button switches and a display for setting the demand level at which an integral set of Form C contacts shall be operated to initiate indicated action.
   4. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
   5. Identification: Comply with Division 26 Section "Electrical Identification."
   6. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
   7. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.
      a. Type: Split and solid core.
   8. Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI C12.1.
   9. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

3.2 FIELD QUALITY CONTROL

A. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.
   1. Connect a load of known kilowatt rating to a circuit supplied by metered feeder.
   2. Turn off circuits supplied by metered feeder and secure them in off condition.

3. Run test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.
5. Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

END OF SECTION 26 2713

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SECTION 26 2726
WIRING DEVICES

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. Single and duplex receptacles
   2. Receptacles with integral USB charger.
   3. Ground-fault circuit interrupter receptacles
   4. Single- and double-pole snap switches.
   5. Device wall plates.
   6. Pin and sleeve connectors and receptacles.
   7. Floor service fittings

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. AFCI: Arc-fault circuit interrupter.
D. PVC: Polyvinyl chloride.
E. RFI: Radio-frequency interference.
F. SPD: Surge protective devices.

G. UTP: Unshielded twisted pair.
H. USB: Universal serial bus.

1.4 REFERENCES

A. IEC 309-1, Part 1: General Requirements: Plugs, Socket-Outlets and Couplers for Industrial Purposes
B. NEMA FB 11: Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
C. NEMA WD 1: General Requirements for Wiring Devices.
D. NEMA WD 6: Wiring Device – Dimensional Requirements.
E. UL 20: General-Use Snap Switches.
F. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
G. UL 486B: Wire Connectors for Use with Aluminum Conductors.
H. UL 498: Electrical Attachment Plugs and Receptacles.
I. UL 943: Ground Fault Circuit Interrupters.
J. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations for each type of product indicated.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and source.
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 NFPA 70.

1.7 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 GENERAL WIRING DEVICE REQUIREMENTS

A. Comply with NFPA 70, NEMA WD 1, NEMA WD 6, and UL498.
B. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.
C. Device Color:
   1. Wiring Devices Connected to Normal Power System: Black, unless otherwise indicated or required by NFPA 70 or device listing.
   2. Wall Switches: Black, unless otherwise indicated.

2.2 STANDARD GRADE RECEPTACLES

A. Duplex Receptacle, NEMA 5-20R:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Wire Device-Kellems: 5352
      b. Eaton/Arrow Hart Wiring Devices: 5362
      c. Leviton: 5362
      d. Legrand, Pass & Seymour: 5362
B. Weather-Resistant Duplex Receptacle, NEMA 5-20R:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Hubbell Wire Device-Kellems: BR20WR
    b. Eaton/Arrow Hart Wiring Devices: WRBR20
    c. Leviton: WBR20
    d. Legrand, Pass & Seymour: WR20TR

2.3 USB RECEPTACLES

A. Tamper-Resistant Duplex NEMA 5-20R and USB Charging Receptacle:
    1. Decorator style.
    2. Comply with UL 1310.
    3. USB Charging 3.0A (minimum), 5VDC dual ports.
        a. Comply with battery charging specification USB BC1.2
        b. Compatible with USB 1.1/2.0/3.0 devices, including Apple products.
    4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Hubbell Wiring Device: USB20X2-x
        b. Eaton/Arrow Hart Wiring Devices: TR7756-x
        c. Leviton: T5632
        d. Legrand, Pass & Seymour: TR5362USB Full Duplex and USB

2.4 GFCI RECEPTACLES

A. General:
    1. Comply with UL 943
B. Duplex GFCI Receptacle, NEMA 5-20R:
    1. Manufacturers: Subject to compliance with requirements, provide one of the following:
        a. Hubbell Wiring Device-Kellems: GFRST20
        b. Eaton/Arrow Hart Wiring Devices: SGF20
        c. Leviton: GFNT2
        d. Legrand, Pass & Seymour: 2097
C. Weather-Resistant Duplex GFCI Receptacle, NEMA 5-20R:
    1. Comply with UL 943.
    2. Manufacturers: Subject to compliance with requirements, provide one of the following:
        a. Eaton/Arrow Hart Wiring Devices WRSGF20
        b. Leviton: GFWR2
        c. Legrand, Pass & Seymour: 2097TRWR

2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES AND WALL SWITCHES

A. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11 and UL 1203.
    1. Class I.
        a. Division: 2.
        b. Zone: 2.

2.6 STRAIGHT BLADE AND TWIST-LOCK RECEPTACLES, OTHER THAN NEMA 5-20R

A. Provide commercial specification grade straight blade and twist-lock receptacles with standard NEMA configurations in accordance with the “Special Receptacles” schedule included on the drawings.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Hubbell Wiring Device-Kellems
    2. Eaton/Arrow Hart Wiring Devices
    3. Leviton
    4. Legrand, Pass & Seymour

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking type plug and receptacle body connector, NEMA WD 6, device configurations as indicated on drawings, heavy-duty grade.
B. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
C. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 CORD REELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Reelcraft L4500 Series
   2. Legrand, Pass & Seymour
   3. Hubbell Wiring Device-Kellems
B. Description: Portable cord reel with portable outlet box and receptacle; steel construction NEMA 1 enclosure; adjustable cord stop; spring retractable with latch; 115V, 20A. rated and capable of being ceiling, wall or bench mounted.
C. Cord: 25 feet of 3 no. 12 SJO cord with strain relief.
D. Wiring device: Portable outlet box with liquidtight cord connector and one NEMA 5-20R duplex GFCI receptacle, outlet box and flip-top cover attached to end of cable reel.
E. Electrical Connection: Provide 48 inch (1220 mm) pigtail with NEMA 5-20P plug.

2.10 WALL SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Wiring Device-Kellems: 1220 Series
   2. Eaton/Arrow Hart Wiring Devices: AH1220 Series
   3. Leviton: 1220 Series
   4. Legrand, Pass & Seymour: PS20AC Series
B. Device body: Plastic handle**.**
C. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
D. Snap Switches: Heavy Duty specification grade, quiet type; rated 20A., 120-277 V AC.
E. Provide single-pole, two-pole, three-way and four-way switches as indicated.
F. Provide pilot light where indicated. Switch shall be illuminated when the switch is off.

2.11 WALL PLATES

A. Manufacturers:
   1. Provide wall plates and corresponding wiring devices from same manufacturer.
B. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces:
      a. 0.035-inch- (1-mm-) thick, satin-finished stainless steel
   3. Material for Unfinished Spaces:
      a. Galvanized steel

4. Material for Wet Locations: Gasketed Non-Metallic with hinged cover and listed and labeled as Extra Duty Weatherproof While-In-Use.
    a. Manufacturers:
        1) Hubbell: MM420
        2) Legrand, Pass & Seymour: WIUC10FRED
        3) Eaton/Arrow Hart: WIU-1VX
        4) Red Dot: CKPS
        5) Intermatic: WP5000
5. Material for Damp Locations: Gasketed Cast aluminum with hinged cover and listed and labeled as Weatherproof.
    a. Manufacturers:
        1) Red Dot Model CCGV, ABB Installation Products
        2) Eaton/Arrow Hart WLRD1
        3) Legrand, Pass & Seymour
        4) Intermatic: WP3110MXD

2.12 FLOOR SERVICE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Hubbell Wiring Device-Kellems
    2. Legrand, Wiremold
    3. Steel City
B. Refer to Floor Service Fitting Schedule on Plan.
C. Compartments: Provide barrier separating power from telecommunications cabling. Provide recessed-type floor service fittings with independent compartments and feed through wiring capability.
D. Provide a blank bracket for any unused gangs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Prior to installation of devices, verify wall openings are neatly cut and will be completely covered by wall plates, clean debris from outlet boxes and provide extension rings to bring outlet boxes flush with finished surface.
C. Install devices and assemblies level, plumb, and square with building lines.
D. Arrangement of Devices:
    1. Coordinate locations of outlet boxes provided under Division 26 Section "Raceways and Boxes" to obtain mounting heights indicated on Drawings.
    2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top.
    3. Where multiple switches, dimmers, and/or occupancy sensors are adjacent to each other, provide a single cover plate. Custom fabricate, if required, for all combinations. Provide separate boxes or barriers as required for the application.
    4. Install horizontally mounted receptacles with grounding pole on the left.
    5. Install GFCI receptacles so that the "Push To Test" and "Reset" designations can be read correctly. If printed in both directions, install with ground pole on top.
    6. Install switches with OFF position down.
    7. Install pilot switches with the light ON when the switch is OFF.
E. Install cover plates on switch, receptacle, and blank outlets in finished areas.
F. Install weather-resistant type receptacles in all damp and wet locations.
G. Install weatherproof cover plates on receptacles in damp locations.
H. Install weatherproof While-In-Use cover plates on receptacles in wet locations.
I. Use oversized plates for outlets installed in masonry walls.

J. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
K. Remove wall plates and protect devices and assemblies during painting.
L. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
M. Adjust devices and wall plates to be flush and level. Three corners of wall plates must be in contact with wall surfaces. Devices shall be solidly mounted against the box.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification."
   1. Receptacles: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section “Electrical Identification” with black-filled lettering on back side of wall plate, and durable wire markers or tags inside outlet boxes.
   2. Wall Switches: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section “Electrical Identification” with black-filled lettering on back side of wall plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding." Connect wiring device grounding terminal to outlet box with bonding jumper. Use of quick ground strap or screw is not acceptable.
B. Connect wiring according to Division 26 Section "Conductors and Cables." Connect wiring devices by wrapping conductor around screw terminal or by using back wiring and tightening the screw securely.
C. 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. Perform the following field tests and inspections and prepare test reports:
   1. Inspect each wiring device for defects.
   2. Operate each wall switch with circuit energized and verify proper operation.
   3. After installing wiring devices and after electrical circuitry has been energized, test each receptacle for proper polarity, ground continuity, and compliance with requirements.
   4. Test each GFCI receptacle for proper operation with both local and remote fault simulations according to manufacturer's written instructions.
B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 26 2726

SECTION 26 2813
FUSES

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. Cartridge fuses rated 600 V and less for use in switches and controllers.

1.3 SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:
   1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Division 1 include the following:
      a. Let-through current curves for fuses with current-limiting characteristics.
      b. Time-current curves, coordination charts and tables, and related data.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses 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:
   1. NEMA FU 1 – Low Voltage Cartridge Fuses.
   2. NFPA 70 – National Electrical Code.
   3. UL 198C – High-Interrupting-Capacity Fuses, Current-Limiting Types.
   4. UL 198E – Class R Fuses.
   5. UL 512 – Fuseholders.

1.5 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.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

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. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
   3. Ferraz Shawmut, Inc.
   4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.
   1. Feeders: Class J, time delay.
   2. Motor Branch Circuits: Class J, time delay.
   3. Other Branch Circuits: Class J, fast acting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energization at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energization of the circuit in which it is applied.
B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

A. Install labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION 26 2813

SECTION 26 2816
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 1 Specification Sections, apply to this Section.
B. Related Sections include the following:
   1. Division 26 Section “Fuses”.

1.2 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Enclosures.
B. Related Sections:
   1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 DEFINITIONS

A. GD: General duty.
B. GFCI: Ground-fault circuit interrupter.
C. HD: Heavy duty.
D. RMS: Root mean square.
E. SPDT: Single pole, double throw.

1.4 REFERENCES

A. NECA 1: Practices for Good Workmanship in Electrical Contracting.
B. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
D. NEMA AB 1: Molded Case Circuit Breakers and Molded Case Switches.
E. NEMA FU 1: Low Voltage Cartridge Fuses.
F. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
G. NEMA PB1.1: General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
H. NEMA PB2.1: General Instructions for Proper Installation, Operation, and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
I. NFPA 70: National Electrical Code.

1.5 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, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current rating.
   4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Field quality-control test reports including the following:
   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 enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.6 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. 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.

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 switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

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 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:
   1. Eaton Corporation; Cutler-Hammer Products.
   2. General Electric Co.; Electrical Distribution & Control Division.
   3. Siemens Industries, Inc.
   4. Square D/Group Schneider.

B. Fusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, with clips or bolt pads to accommodate specified fuses, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:
   1. Provide early break auxiliary contacts in motor disconnect switches for motors that are fed from variable frequency controllers.
   2. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   3. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
   4. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 TOGGLE DISCONNECT SWITCH

A. Manufacturers:
   1. Double Pole:
      a. Hubbell 1372.
      b. Leviton 6808G-DAC.
      c. Pass & Seymour 7812.
      d. Bryant 30102.
   2. Three Pole:
      a. Hubbell 1379.
      b. Leviton 7810GD.
      c. Pass & Seymour 7813.
      d. Bryant 30103.

B. Description: Heavy duty, 30A, 600 volt, double or three pole as required, single throw, motor rated switch without overload protection. Provide NEMA 1 enclosure and padlock attachment.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
   1. Indoor Dry Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

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.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated.
C. Install switches with off position down.
D. Install NEMA KS 1 enclosed switch where indicated for motor loads ½ HP and larger and equipment loads greater than 30A.
E. Install toggle disconnect switch, surface mounted, where indicated for motor loads less than ½ HP and equipment loads 30A. and less.
F. Install fuses in fusible disconnect switches.
G. Install flexible liquid tight conduit from toggle disconnect switch to portable equipment. Leave a 6'-0" (1830 mm) whip.
H. Install flexible liquid tight conduit from toggle disconnect switch to stationary equipment.
I. Install control wiring from early break contacts in motor disconnect switch to variable frequency controllers to shut down controller when switch is open.
J. Install equipment on exterior foundation walls at least one inch (25 mm) from wall to permit vertical flow of air behind breaker and switch enclosures.
K. Support enclosures independent of connecting conduit or raceway system.
L. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Electrical Identification."
C. Provide adhesive label as specified in Division 26 Section "Electrical Identification" on inside door of each switch indicating UL fuse class and size for replacement.

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:
   1. Inspect mechanical and electrical connections.
   2. Verify switch and relay type and labeling verification.
   3. Verify rating of installed fuses.
B. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches. 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.

3.5 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 20 2923

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SECTION 26 2913
ENCLOSED CONTROLLERS

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 ac, enclosed controllers rated 600 V and less, of the following types:
   1. Across-the-line, manual and magnetic controllers.
B. Related Sections include the following:
   1. Division 20 Section "Variable Frequency Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.
   2. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.
   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. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
   2. Wiring Diagrams: 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 1 include the following:
   1. Routine maintenance requirements for enclosed controllers and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
E. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.4 REFERENCES

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
B. ANSI/UL 198C - High-Intensity Capacity Fuses; Current-Limiting Types.
C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses).
E. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.
F. NEMA AB 1 - Molded Case Circuit Breakers.
G. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
H. NEMA KS 1 - Enclosed Switches.
I. ANSI/NFPA 70 - National Electrical Code.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within ~~100 miles (160 km)~~ of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
B. 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 or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
C. Source Limitations: Obtain enclosed controllers of a single type 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 NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prior to beginning work on any system, verify all existing conditions that affect the work and coordinate with all other trade Contractors. Determine that the work can be

installed as indicated or immediately report to the Architect/Engineer errors, inconsistencies or ambiguities.

B. Deliver products to site under provisions of Section 26 0010. Store and protect products under provisions of Section 26 0010.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions. Lift large equipment only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

E. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of each contactor and indicate circuits controlled. Submit under provisions of 26 0010.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.9 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 installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect. Refer to temperature control plans for additional requirements.

D. 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.

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. Keys: Furnish 2 of each to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Danfoss Inc.; Danfoss Electronic Drives Div.
3. Eaton Corporation; Cutler-Hammer Products.
4. General Electrical Company; GE Industrial Systems.
5. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
6. Siemens/Furnas Controls.
7. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
   1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
   1. Control Circuit: 120 V; obtained from integral control power transformer with sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
   2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
   1. Fusible Disconnecting Means: 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 947-4-1, as certified by an NRTL.
   2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
   3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 VARIABLE FREQUENCY CONTROLLERS

A. Refer to Division 20 “Variable Frequency Controllers.”
B. Equipment furnished by mechanical trades and installed by electrical trades.

2.4 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
   3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
B. Push-Button Stations, Pilot Lights: NEMA ICS 2, heavy-duty type.
C. Indicating Lights: Run (Red), off or ready (Green).
D. Auxiliary Contacts: Provide two normally open (N.O.) and two normally closed (N.C.) contacts.

E. Selector Switch: NEMA ISC 2, mounted in front cover to read “hand/off/auto,” provide auxiliary contact for auto position monitoring.
F. Control Relays: Auxiliary and adjustable time-delay relays.
G. Elapsed Time Meters: Heavy duty with digital readout in hours.

2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount 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. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
C. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."
D. Install motor control equipment and contactors in accordance with manufacturer’s instructions.
E. Select and install heater elements in motor starters to match installed motor characteristics.
F. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.4 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Electrical Identification."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Conductors and Cables."
B. Bundle, train, and support wiring in enclosures.
C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
B. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”
   1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters”. 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.

3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 1.

END OF SECTION 26 2913

SECTION 26 5119
LED 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 solid-state luminaires that use LED technology.
   2. Lighting fixture supports.
B. Related Requirements:
   1. Division 26 "Lighting Control Devices".
   2. Division 26 "Lighting Control Systems".

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.

E. Lamp: LED and substrate as a replaceable assembly.
F. LED: Light-emitting diode.
G. Lumen: Measured output of lamp and luminaire, or both.
H. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBMITTALS

A. Product Data: For each type of product.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaires.
   4. Include emergency lighting units, including batteries and chargers.
   5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project per IES LM-79 and IES LM-80.
      a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products or certified by a qualified independent testing agency.
B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire 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.
C. Coordination Drawings: Reflected ceiling plan(s) 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. Lighting luminaires.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
   4. Structural members to which luminaires will be attached.
   5. Initial access modules for acoustical tile, including size and locations.
   6. Items penetrating finished ceiling, including the following:
      a. Other luminaires.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Ceiling-mounted projectors.
D. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

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. LED Drivers 1% attic stock of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
B. Provide luminaires from a single manufacturer for each luminaire type.
C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
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:
   1. NFPA 70 - National Electrical Code.
   2. NECA/IESNA 500-1998 – Recommended Practice for Installing Indoor Commercial Lighting Systems.
   3. NECA/IESNA 502-1999 – Recommended Practice for Installing Industrial Lighting Systems.
   4. Code of Federal Regulations (47 CFR 37342).
F. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
G. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

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.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
B. Warranty Period: Five year(s) or manufacturer’s standard warranty length (whichever is longer) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRES (LIGHTING FIXTURES)

A. Provide Luminaires as included in specification 26 5700 “Luminaire Product Data.” This section contains product data sheets from the basis of design manufacturer with annotations.
B. Acceptable alternate manufacturers are indicated on the product data sheets. Alternate manufacturer products shall be equal in all respects including materials, finishes, photometric performance and energy performance and shall include all options, features, and accessories identified.
C. The Luminaire schedule shown on the drawings is supplemental provided for convenience and reference only. The requirements of this section and 26 5700 shall govern.

2.2 LUMINAIRE REQUIREMENTS

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. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
D. Unless otherwise specified in Luminaire product data, provide products with a minimum CRI of 80.
E. Unless otherwise specified in Luminaire product data, provide products with a CCT of 3500K.
F. Unless otherwise specified in Luminaire product data, provide products with a minimum IES LM-80 rated lamp life of 50,000 hours.
G. Driver
    1. Provided as an integrated component of the luminaire or as an external component of an assembly of luminaries.
    2. Nominal Input Voltage: As specified in product data.

2.3 EXIT SIGNS

A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.
B. Internally Lighted Signs:
    1. Lamps: Light-emitting diodes, 70,000 hours minimum of rated lamp life.
C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
    2. Charger: Fully automatic, solid-state type with sealed transfer relay.
    3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
D. Provide a mirror plaque background for edge lit signs.

2.4 INTERNAL TYPE EMERGENCY POWER UNIT

A. General: Self-contained, modular, battery-inverter unit, factory mounted within luminaire complying with UL 924.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Signify: Bodine
    2. Iota.
    3. Dual Lite.
    4. Lithonia.
C. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire driver.
D. Operation: Relay automatically turns luminaire on when power fails. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects luminaire from battery, and battery is automatically recharged.
E. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
    1. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    2. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

F. Battery: Sealed, maintenance-free, nickel-cadmium type.
G. Refer to 265700 Luminaire Product Data for wattage and lumen output requirements for each luminaire.

2.5 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.
B. 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.
C. Diffusers and Globes:
   1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
D. Factory-Applied Labels: Comply with UL 1598 Locate labels 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 characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage, and coating.
      c. CCT and CRI for all luminaires.

2.6 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.7 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
B. Single-Stem Hangers: Unless otherwise specified in Luminaire product data, provide products with a minimum 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
C. Wires: Unless otherwise specified in Luminaire product data, provide products with a minimum ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
D. Rod Hangers: Unless otherwise specified in Luminaire product data, provide products with a minimum 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

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 luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. Do not use permanent luminaires for temporary lighting.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions and N.E.C.A./I.E.S.N.A. 500-2006 and 502-2006.
B. Locate ceiling luminaires as indicated on reflected ceiling plan.
C. Support luminaires independent of ceiling framing. Support recessed grid luminaries from two opposite corners directly to structure. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
D. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.
E. Install recessed luminaires to permit removal from below.
F. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
G. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
H. Supports:
    1. Sized and rated for luminaire weight.
    2. Able to maintain luminaire position after cleaning and relamping.
    3. Provide support for luminaire without causing deflection of ceiling or wall.
    4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
I. Flush-Mounted Luminaire Support:
    1. Secured to outlet box.
    2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
    3. Trim ring flush with finished surface.
J. Wall-Mounted Luminaire Support:
    1. Attached to structural members in walls.
    2. Do not attach luminaires directly to gypsum board.
K. Ceiling-Mounted Luminaire Support:
    1. Ceiling mount per manufacturer's product data sheet.
L. Suspended Luminaire Support:
    1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
    2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
    3. Continuous Rows of Luminaires: Coordinate with manufacturers installation details for continuous mounting.
    4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
M. Comply with requirements in Section 26 0519 "Conductors and Cables" for wiring connections.

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 wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
C. Bond products and metal accessories to branch circuit equipment grounding conductor.
D. Connect luminaires to branch circuit outlet boxes provided under Division 26 Section "Raceways and Boxes" using 1/2" flexible conduit.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Electrical Identification."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. A visual inspection shall be performed to verify cleanliness and alignment of the fixtures, misalignment and light leaks shall be corrected, and rattles due to ventilation system vibration shall be eliminated.

3.7 STARTUP SERVICE

A. Comply with requirements for startup specified in Division 26 "Lighting Control Systems."

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
   1. During adjustment visits, inspect all luminaires. Replace lamps, drivers, or luminaires that are defective.
   2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   3. Adjust the aim of luminaires in the presence of the Architect and Engineer.

B. Adjust exit sign directional arrows as indicated on Drawings.

C. Adjust and calibrate all dimming system controls until the system works as designed. Contact the Architect/Engineer when dimming is complete and demonstrate operation to owner’s representative and Architect/Engineer.

3.9 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures and lenses.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

END OF SECTION 26 5119

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SECTION 26 5600
EXTERIOR LIGHTING

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. Exterior luminaires
   2. Poles and accessories.
B. Related Sections include the following:
   1. Division 26 Section "LED Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 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.
      a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   6. Photoelectric relays.
   7. Ballasts, including energy-efficiency data.

8. Lamps, including life, output, and energy-efficiency data.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.
12. Manufactured pole foundations.

B. Shop Drawings:
1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Wiring Diagrams: Power wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 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. 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 C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

1.5 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.

1.6 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.
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 Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
5. 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 LUMINAIRES (LIGHTING FIXTURES)

A. Provide Luminaires as included in specification 26 5700 “Luminaire Product Data.” This section contains product data sheets from the basis of design manufacturer with annotations.

B. Acceptable alternate manufacturers are indicated on the product data sheets. Alternate manufacturer products shall be equal in all respects including materials, finishes, photometric performance and energy performance and shall include all options, features, and accessories identified.

2.2 LUMINAIRE GENERAL REQUIREMENTS

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. 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.

2.3 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
B. 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 stainless-steel items are indicated.
    3. Anchor-Bolt Template: Plywood or steel.
C. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

2.4 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
    1. Shape: Round, straight
    2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
E. 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.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install exterior lighting system per N.E.C.A./I.E.S.N.A. 501-2006.
B. Install lamps in each luminaire.
C. Fasten luminaire to indicated structural supports.

3.2 POLE INSTALLATION

A. 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
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 3 Section "Cast-in-Place Concrete."
D. Raise and set poles using web fabric slings (not chain or cable).

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 "Raceways and Boxes." 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."

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 26 5600

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LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L1A

FEATURES & SPECIFICATIONS

INTENDED USE — The RTL combines digital LED lighting and controls technologies with patented high-performance optical design to offer the most advanced luminaire for general-ambient lighting applications. High-efficacy light engine delivers long life and excellent color, ensuring a superior quality lighting installation that is highly efficient and sustainable.

CONSTRUCTION — Rugged, one-piece cold-rolled steel reflector assembly with embossed facets. Coated polyester powder-paint after fabrication.

Rigid structure with ballast box and end plates. End plates include integral T-bar clips.

Impact-modified acrylic prismatic refractor

Luminaires may be mounted end-to-end and continuously wired.

OPTICS — Volumetric illumination is delivered by creating an optimal mix of light to walls, partitions, vertical and horizontal work surfaces — rendering the interior space, objects and occupants in a more balanced, complementary luminous environment.

Light distribution is carefully controlled at high angles, providing just enough luminous flux to create the volumetric effect.

Linear faceted reflector cavity softens and distributes light into the space while minimizing luminous contrast between the fixture and ceiling.

Sloped end plates provide a smooth, luminous transition between fixture and ceiling while enhancing the perception of fixture depth.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. RTL is rated to deliver L90 performance for 60,000 hours.

Optional integrated nLight® controls make each luminaire addressable - allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices and the RTL luminaires using standard CAT-5 cabling. Unique plug-and-play convenience as devices and luminaires automatically discover each other and self-commission.

Lumen Management: Unique lumen management system (option N80) provides onboard intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life, preventing the energy waste created by the traditional practice of over-lighting.

Step-level dimming option allows system to be switched to 50% power for compliance with common energy codes while maintaining fixture appearance.

eldoLED driver options deliver choice of dimming range, and choice of control, while assuring flicker-free, low current inrush, 89% efficiency and low EMI.

Driver disconnect provided where required to comply with US and Canadian codes.

INSTALLATION — Drivers and internal components accessed via plenum. Driver tray may be removed from fixture during service. Suitable for damp location.

Maintenance: LED boards include plug-in connectors for easy replacement or servicing.

LISTINGS — CSA Certified to meet U.S. and Canadian standards. IC rated.

Tested to LM80 standards. IC rated. DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

Protected by one or more of US Patent Nos. 7,229,192; D541,467; D541,468; D544,633; D544,634; D544,992. D544,933 and additional patents pending.

BUY AMERICAN — Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. Please refer to www.acuitybrands.com/buy-american for additional information.

ARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

RT LED

Volumetric Lighting

2RTL4

2' X 4'
LED

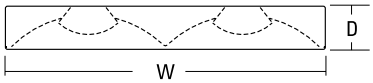
Buy American · A+ CAPABLE · eldoLED · DLC DLC QPL LISTED · nLIGHT

Dimensions

All dimensions are inches (centimeters) unless otherwise specified.

Specifications

Length: 48 (121.9)
Width: 24 (61.0)
Depth: 3-1/8 (7.9)



Approved Alternate Manufacturers:
Metalux "24AC" Series
LSI "ASC" Series

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

2RTL Volumetric Recessed Lighting 2'x4'

A+ Capable options indicated by this color background.

L1A

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: 2RTL4 48L EZ1 LP835 N80

2RTL4

Series	Air function	Lumens	Voltage	Driver	Color temperature	Controls[5]	Option
2RTL4 Recessed 2X4 LED	(blank) No air	30L 3000[1]	(blank) MVOLT (120 - 277V)	EZ1 eldoLED dims to 1% (0-10 volt dimming)	LP830 3000 K, 82 CRI	(blank) No controls	EL7L 700 nominal lumen battery pack (Noncompliant with CA T20)
	CAS Center air slots (air removal)	40L 4000[1]	347 347[2]	EZB eldoLED dims to 0.1% (0-10 volt dimming)	LP835 3500 K, 82 CRI	N80 nLight with 80% lumen management	EL14L 1400 nominal lumen battery pack (Noncompliant with CA T20)
		48L 4800[1]		GZ1 Dims to 1% (0-10V dimming)[3]	LP840 4000 K, 82 CRI	N80EMG nLight with 80% lumen management for use with generator supply EM power[6]	E10WLCP EM Self-Diagnostic battery pack, 10W Constant Power, Certified in CA Title 20 MAEDBS
		60L 6000[1]		GZ10 Dims to 10% (0-10V dimming)[3]	LP850 5000 K, 82 CRI	N100 nLight without lumen management	CP Chicago plenum
		72L 7200[1]		EDB eldoLED DALI[3]		N100EMG nLight without lumen management for use with generator supply EM power[6]	BAA Buy America(n) Act Compliant
				SLD Step-level dimming[3]			
				EXA1 Dims to 1%, XPoint wireless enabled[3,4]			
				EXAB Dims to dark, XPoint wireless enabled[3,4]			

Provide for EM lights only

Accessories: *Order as separate catalog number.*

DGA24	Drywall ceiling adaptor , unit installation
2X4SMKSHP PAF	Multi-Use Surface Mount Kit 2X4 Post-Paint

Notes

1 Approximate lumen output.
2 Not available with EL battery packs or SLD driver.
3 Not available with N80, N80EMG, N100, or N100EMG.
4 Gateway not included. Requires on-site commissioning. Visit www.lightingcontrols.com/XPointWireless for more information.
5 nLight access limitations with EZB.
6 nLight EMG option requires a connection to existing nLight network. Power is provided from a separate N80 or N100 enabled fixture.

Performance Data

Lumen Package	Lumens	Input Watts	LPW
30L LP830	3144	29.2	107
30L LP835	3238	29.2	110
30L LP840	3303	29.2	113
30L LP850	3369	29.2	115
40L LP830	4699	39.4	119
40L LP835	4840	39.4	123
40L LP840	4905	39.4	124
40L LP850	5003	39.4	127
48L LP830	5639	47.3	119
48L LP835	5808	47.3	123
48L LP840	5886	47.3	124
48L LP850	6004	47.3	127
60L LP830	6079	55.3	109
60L LP835	6261	55.3	113
60L LP840	6387	55.3	115
60L LP850	6514	55.3	117
72L LP830	7495	69.7	107
72L LP835	7720	69.7	110
72L LP840	7874	69.7	113
72L LP850	8032	69.7	115

How to Estimate Delivered Lumens in Emergency Mode
Use the formula below to estimate the delivered lumens in emergency mode.
Delivered Lumens = 1.25 x P x LPW
P = Ouput power of emergency driver. P = 10W for E10WLCP option.
LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.
LPW = Lumen per watt rating of the luminaire. LPW information available in Performance Data section.

COMMERCIAL INDOOR: One Lithonia Way Conyers, GA 30012 Phone: 800-705-SERV (7378) www.lithonia.com

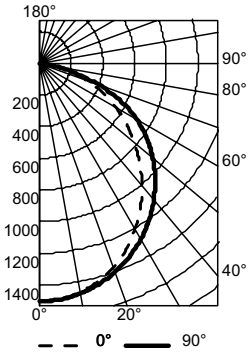
Rev. 04/29/2021

2RTL Volumetric Recessed Lighting 2'x4'

L1A

PHOTOMETRICS

2RTL4 40L LP835, 4,118 delivered lumens, test no. LTL25588P4, tested in accordance to IESNA LM-79 .



CP Summary

	0°	90
0°	1499	1499
5°	1492	1497
15°	1425	1443
25°	1294	1345
35°	1111	1207
45°	897	1033
55°	669	826
65°	442	570
75°	226	230
85°	44	16
90	0	0

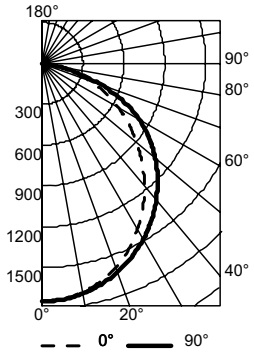
Coefficients of Utilization

pf	20%								
pc	80%			70%			50%		
RCR pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	109	104	100	102	98	95	98	95	92
2	99	91	84	89	83	78	86	80	76
3	90	80	72	78	71	65	75	69	64
4	83	71	62	70	61	55	67	60	54
5	76	63	54	62	54	48	60	53	47
6	70	57	48	56	48	42	54	47	41
7	65	52	43	51	43	37	49	42	36
8	61	47	39	46	38	33	45	38	33
9	57	43	35	43	35	29	42	34	29
10	53	40	32	39	32	27	38	31	27

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1152	28.0	28.0
0° - 40°	1875	45.5	45.5
0° - 60°	3294	80.0	80.0
0° - 90°	4118	100.0	100.0
90° - 120°	0	0.0	0.0
90° - 130°	0	0.0	0.0
90° - 150°	0	0.0	0.0
90° - 180°	0	0.0	0.0
0° - 180°	4118	100.0	100.0

2RTL4 48L LP835, 4,786 delivered lumens, test no. LTL25588P8, tested in accordance to IESNA LM-79.



CP Summary

	0°	90
0°	1743	1743
5°	1735	1739
15°	1657	1677
25°	1504	1563
35°	1291	1402
45°	1043	1200
55°	778	960
65°	514	663
75°	262	267
85°	51	19
90	0	0

Coefficients of Utilization

pf	20%								
pc	80%			70%			50%		
RCR pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	109	104	100	102	98	95	98	95	92
2	99	91	84	89	83	78	86	80	76
3	90	80	72	78	71	65	75	69	64
4	83	71	62	70	61	55	67	60	54
5	76	63	54	62	54	48	60	53	47
6	70	57	48	56	48	42	54	47	41
7	65	52	43	51	43	37	49	42	36
8	61	47	39	46	38	33	45	38	33
9	57	43	35	43	35	29	42	34	29
10	53	40	32	39	32	27	38	31	27

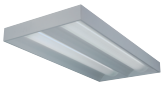
Zonal Lumen Summary

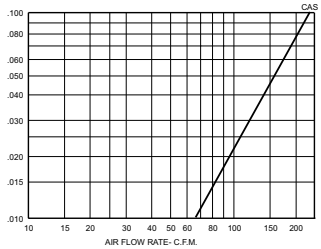
Zone	Lumens	% Lamp	% Fixture
0° - 30°	1339	28.0	28.0
0° - 40°	2179	45.5	45.5
0° - 60°	3828	80.0	80.0
0° - 90°	4786	100.0	100.0
90° - 120°	0	0.0	0.0
90° - 130°	0	0.0	0.0
90° - 150°	0	0.0	0.0
90° - 180°	0	0.0	0.0
0° - 180°	4786	100.0	100.0

nLight® Control Accessories:
Order as separate catalog number. Visit www.sensorswitch.com/nLight for complete listing of nLight controls.

WallPod stations	Model number	Occupancy sensors	Model number
On/Off	nPODM [color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 / nCM PDT 9
On/Off & Raise/Lower	nPODM DX [color]	Large motion 360°, ceiling (PIR / dual tech)	nCM 10 / nCM PDT 10
Graphic Touchscreen	nPOD GFX	Wall switch with raise/lower	nWSXPDTLVDX
Photocell controls	**Model number**	**Cat-5 cable bundles (plenum rated)**	**Model number**
On/Off & Dimming	nCM ADCX	10', 15 pieces per bundle	CAT5 10FT
		30', 15 pieces per bundle	CAT5 30FT

RTL with Air Handling

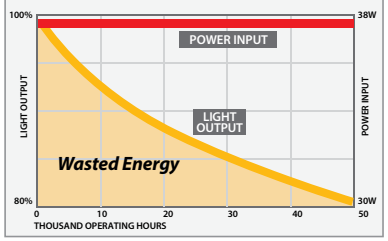




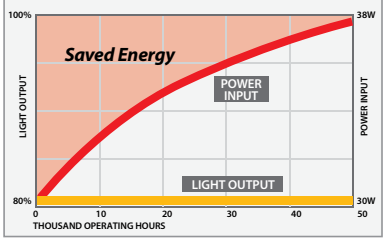
Constant Lumen Management

Enabled by the embedded nLight control, the RTL actively tracks its run-time and manages its light source such that constant lumen output is maintained over the system life. Referred to as lumen management, this feature eliminates the energy waste created by the traditional practice of over-lighting.

Without Lumen Management
Energy is wasted and light level is inconsistent.



With Lumen Management
Energy is saved and light level remains consistent.



LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L1B

RT LED

Volumetric Lighting

2RTL4

2' X 4'
LED

Buy American · A+ CAPABLE · eldoLED · DLC · nLIGHT

FEATURES & SPECIFICATIONS

INTENDED USE — The RTL combines digital LED lighting and controls technologies with patented high-performance optical design to offer the most advanced luminaire for general-ambient lighting applications. High-efficacy light engine delivers long life and excellent color, ensuring a superior quality lighting installation that is highly efficient and sustainable.

CONSTRUCTION — Rugged, one-piece cold-rolled steel reflector assembly with embossed facets. Coated polyester powder-paint after fabrication.

Rigid structure with ballast box and end plates. End plates include integral T-bar clips.

Impact-modified acrylic prismatic refractor

Luminaires may be mounted end-to-end and continuously wired.

OPTICS — Volumetric illumination is delivered by creating an optimal mix of light to walls, partitions, vertical and horizontal work surfaces — rendering the interior space, objects and occupants in a more balanced, complementary luminous environment.

Light distribution is carefully controlled at high angles, providing just enough luminous flux to create the volumetric effect.

Linear faceted reflector cavity softens and distributes light into the space while minimizing luminous contrast between the fixture and ceiling.

Sloped end plates provide a smooth, luminous transition between fixture and ceiling while enhancing the perception of fixture depth.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. RTL is rated to deliver L90 performance for 60,000 hours.

Optional integrated nLight® controls make each luminaire addressable - allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices and the RTL luminaires using standard CAT-5 cabling. Unique plug-and-play convenience as devices and luminaires automatically discover each other and self-commission.

Lumen Management: Unique lumen management system (option N80) provides onboard intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life, preventing the energy waste created by the traditional practice of over-lighting.

Step-level dimming option allows system to be switched to 50% power for compliance with common energy codes while maintaining fixture appearance.

eldoLED driver options deliver choice of dimming range, and choice of control, while assuring flicker-free, low current inrush, 89% efficiency and low EMI.

Driver disconnect provided where required to comply with US and Canadian codes.

INSTALLATION — Drivers and internal components accessed via plenum. Driver tray may be removed from fixture during service. Suitable for damp location.

Maintenance: LED boards include plug-in connectors for easy replacement or servicing.

LISTINGS — CSA Certified to meet U.S. and Canadian standards. IC rated.

Tested to LM80 standards. IC rated. DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

Protected by one or more of US Patent Nos. 7,229,192; D541,467; D541,468; D544,633; D544,634; D544,992. D544,933 and additional patents pending.

BUY AMERICAN — Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. Please refer to www.acuitybrands.com/buy-american for additional information.

ARRANTY — 5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/support/warranty/terms-and-conditions

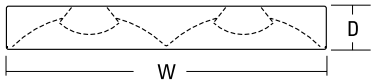
Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

Dimensions

All dimensions are inches (centimeters) unless otherwise specified.

Specifications

Length: 48 (121.9)
Width: 24 (61.0)
Depth: 3-1/8 (7.9)



Approved Alternate Manufacturers:
Metalux "24AC" Series
LSI "ASC" Series

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

2RTL Volumetric Recessed Lighting 2'x4'

A+ Capable options indicated by this color background.

L1B

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: 2RTL4 48L EZ1 LP835 N80

2RTL4

Series	Air function	Lumens	Voltage	Driver	Color temperature	Controls[5]	Option
2RTL4 Recessed 2X4 LED	(blank) No air	30L 3000[1]	(blank) MVOLT (120 - 277V)	EZ1 eldoLED dims to 1% (0-10 volt dimming)	LP830 3000 K, 82 CRI	(blank) No controls	EL7L 700 nominal lumen battery pack (Noncompliant with CA T20)
	CAS Center air slots (air removal)	40L 4000[1]	347 347[2]	EZB eldoLED dims to 0.1% (0-10 volt dimming)	LP835 3500 K, 82 CRI	N80 nLight with 80% lumen management	EL14L 1400 nominal lumen battery pack (Noncompliant with CA T20)
		48L 4800[1]		GZ1 Dims to 1% (0-10V dimming)[3]	LP840 4000 K, 82 CRI	N80EMG nLight with 80% lumen management for use with generator supply EM power[6]	E10WLCP EM Self-Diagnostic battery pack, 10W Constant Power, Certified in CA Title 20 MAEDBS
		60L 6000[1]		GZ10 Dims to 10% (0-10V dimming)[3]	LP850 5000 K, 82 CRI	N100 nLight without lumen management	CP Chicago plenum
		72L 7200[1]		EDB eldoLED DALI[3]		N100EMG nLight without lumen management for use with generator supply EM power[6]	BAA Buy America(n) Act Compliant
				SLD Step-level dimming[3]			
				EXA1 Dims to 1%, XPoint wireless enabled[3,4]			
				EXAB Dims to dark, XPoint wireless enabled[3,4]			

Provide for EM lights only

Accessories: *Order as separate catalog number.*

DGA24	Drywall ceiling adaptor , unit installation
2X4SMKSHP PAF	Multi-Use Surface Mount Kit 2X4 Post-Paint

Notes

1 Approximate lumen output.
2 Not available with EL battery packs or SLD driver.
3 Not available with N80, N80EMG, N100, or N100EMG.
4 Gateway not included. Requires on-site commissioning. Visit www.lightingcontrols.com/XPointWireless for more information.
5 nLight access limitations with EZB.
6 nLight EMG option requires a connection to existing nLight network. Power is provided from a separate N80 or N100 enabled fixture.

Performance Data

Lumen Package	Lumens	Input Watts	LPW
30L LP830	3144	29.2	107
30L LP835	3238	29.2	110
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48L LP850	6004	47.3	127
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60L LP840	6387	55.3	115
60L LP850	6514	55.3	117
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How to Estimate Delivered Lumens in Emergency Mode
Use the formula below to estimate the delivered lumens in emergency mode.
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LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.
LPW = Lumen per watt rating of the luminaire. LPW information available in Performance Data section.

COMMERCIAL INDOOR: One Lithonia Way Conyers, GA 30012 Phone: 800-705-SERV (7378) www.lithonia.com

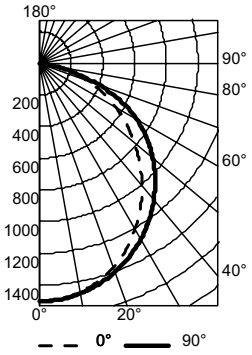
Rev. 04/29/2021

2RTL Volumetric Recessed Lighting 2'x4'

L1B

PHOTOMETRICS

2RTL4 40L LP835, 4,118 delivered lumens, test no. LTL25588P4, tested in accordance to IESNA LM-79 .



CP Summary

	0°	90
0°	1499	1499
5°	1492	1497
15°	1425	1443
25°	1294	1345
35°	1111	1207
45°	897	1033
55°	669	826
65°	442	570
75°	226	230
85°	44	16
90	0	0

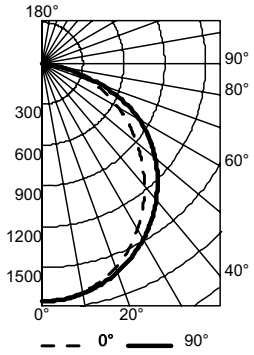
Coefficients of Utilization

	pf	20%								
	pc	80%			70%			50%		
	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
RCR	0	119	119	119	116	116	116	111	111	111
	1	109	104	100	102	98	95	98	95	92
	2	99	91	84	89	83	78	86	80	76
	3	90	80	72	78	71	65	75	69	64
	4	83	71	62	70	61	55	67	60	54
	5	76	63	54	62	54	48	60	53	47
	6	70	57	48	56	48	42	54	47	41
	7	65	52	43	51	43	37	49	42	36
	8	61	47	39	46	38	33	45	38	33
	9	57	43	35	43	35	29	42	34	29
	10	53	40	32	39	32	27	38	31	27

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1152	28.0	28.0
0° - 40°	1875	45.5	45.5
0° - 60°	3294	80.0	80.0
0° - 90°	4118	100.0	100.0
90° - 120°	0	0.0	0.0
90° - 130°	0	0.0	0.0
90° - 150°	0	0.0	0.0
90° - 180°	0	0.0	0.0
0° - 180°	4118	100.0	100.0

2RTL4 48L LP835, 4,786 delivered lumens, test no. LTL25588P8, tested in accordance to IESNA LM-79.



CP Summary

	0°	90
0°	1743	1743
5°	1735	1739
15°	1657	1677
25°	1504	1563
35°	1291	1402
45°	1043	1200
55°	778	960
65°	514	663
75°	262	267
85°	51	19
90	0	0

Coefficients of Utilization

	pf	20%								
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	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
RCR	0	119	119	119	116	116	116	111	111	111
	1	109	104	100	102	98	95	98	95	92
	2	99	91	84	89	83	78	86	80	76
	3	90	80	72	78	71	65	75	69	64
	4	83	71	62	70	61	55	67	60	54
	5	76	63	54	62	54	48	60	53	47
	6	70	57	48	56	48	42	54	47	41
	7	65	52	43	51	43	37	49	42	36
	8	61	47	39	46	38	33	45	38	33
	9	57	43	35	43	35	29	42	34	29
	10	53	40	32	39	32	27	38	31	27

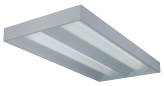
Zonal Lumen Summary

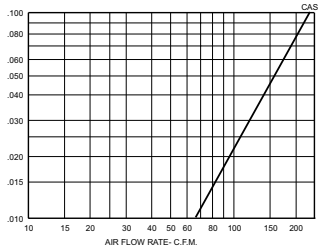
Zone	Lumens	% Lamp	% Fixture
0° - 30°	1339	28.0	28.0
0° - 40°	2179	45.5	45.5
0° - 60°	3828	80.0	80.0
0° - 90°	4786	100.0	100.0
90° - 120°	0	0.0	0.0
90° - 130°	0	0.0	0.0
90° - 150°	0	0.0	0.0
90° - 180°	0	0.0	0.0
0° - 180°	4786	100.0	100.0

nLight® Control Accessories:
Order as separate catalog number. Visit www.sensorswitch.com/nLight for complete listing of nLight controls.

WallPod stations	Model number	Occupancy sensors	Model number
On/Off	nPODM [color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 / nCM PDT 9
On/Off & Raise/Lower	nPODM DX [color]	Large motion 360°, ceiling (PIR / dual tech)	nCM 10 / nCM PDT 10
Graphic Touchscreen	nPOD GFX	Wall switch with raise/lower	nWSXPDTLVDX
Photocell controls	**Model number**	**Cat-5 cable bundles (plenum rated)**	**Model number**
On/Off & Dimming	nCM ADCX	10', 15 pieces per bundle	CAT5 10FT
		30', 15 pieces per bundle	CAT5 30FT

RTL with Air Handling

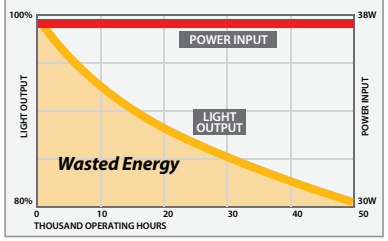




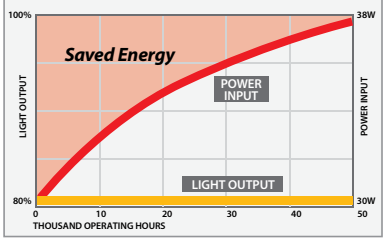
Constant Lumen Management

Enabled by the embedded nLight control, the RTL actively tracks its run-time and manages its light source such that constant lumen output is maintained over the system life. Referred to as lumen management, this feature eliminates the energy waste created by the traditional practice of over-lighting.

Without Lumen Management
Energy is wasted and light level is inconsistent.



With Lumen Management
Energy is saved and light level remains consistent.



LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L2

FEATURES & SPECIFICATIONS

INTENDED USE — The RTL combines digital LED lighting and controls technologies with patented high-performance optical design to offer the most advanced luminaire for general-ambient lighting applications. High-efficacy light engine delivers long life and excellent color, ensuring a superior quality lighting installation that is highly efficient and sustainable.

CONSTRUCTION — Rugged, one-piece cold-rolled steel reflector assembly with embossed facets. Coated polyester powder-paint after fabrication.

Rigid structure with ballast box and end plates. End plates include integral T-bar clips.

Impact-modified acrylic prismatic refractor.

Luminaires may be mounted end-to-end and continuously wired.

OPTICS — Volumetric illumination is delivered by creating an optimal mix of light to walls, partitions, vertical and horizontal work surfaces — rendering the interior space, objects and occupants in a more balanced, complementary luminous environment.

Light distribution is carefully controlled at high angles, providing just enough luminous flux to create the volumetric effect.

Linear faceted reflector cavity softens and distributes light into the space while minimizing luminous contrast between the fixture and ceiling.

Sloped end plates provide a smooth, luminous transition between fixture and ceiling while enhancing the perception of fixture depth.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. RTL is rated to deliver L90 performance for 60,000 hours.

Optional integrated nLight® controls make each luminaire addressable - allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices and the RTL luminaires using standard CAT-5 cabling. Unique plug-and-play convenience as devices and luminaires automatically discover each other and self-commission.

Lumen Management: Unique lumen management system (option N80) provides onboard intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life, preventing the energy waste created by the traditional practice of over-lighting.

Step-level dimming option allows system to be switched to 50% power for compliance with common energy codes while maintaining fixture appearance.

eldoLED driver options deliver choice of dimming range, and choice of control, while assuring flicker-free, low current inrush, 89% efficiency and low EMI.

Driver disconnect provided where required to comply with US and Canadian codes.

INSTALLATION — Drivers and internal components accessed via plenum. Driver tray may be removed from fixture during service. Suitable for damp location.

Maintenance: LED boards include plug-in connectors for easy replacement or servicing.

LISTINGS — CSA Certified to meet U.S. and Canadian standards. IC rated.

Tested to LM80 standards. IC rated. DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

Protected by one or more of US Patent Nos. 7,229,192; D541,467; D541,468; D544,633; D544,634; D544,992. D544,933 and additional patents pending.

BUY AMERICAN — Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

RT LED

Volumetric Lighting

2RTL2

2' X 2'
LED

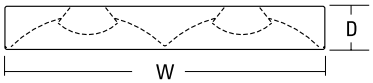
Buy American · A+ CAPABLE · eldoLED · DLC DesignLights Consortium QPL · nLIGHT

Dimensions

All dimensions are inches (centimeters) unless otherwise specified.

Specifications

Length: 24 (61.0)
Width: 24 (61.0)
Depth: 3-1/8 (7.9)



Approved Alternate Manufacturers:
Metalux "22AC" Series
LSI "ASC" Series

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

2RTL Volumetric Recessed Lighting 2'x2'

A+ Capable options indicated by this color background.

L2

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: 2RTL2 33L EZ1 LP835 N80

2RTL2

Series	Air function	Lumens[1]	Voltage	Driver	Color temperature	Controls	Options
2RTL2 Recessed 2X2 LED	(blank) No air	20L 2000 lumens	(blank) MVOLT (120 - 277V)	EZ1 eldoLED dims to 1% (0-10 volt dimming)	LP830 3000 K, 82CRI	(blank) No controls	EL7L 700 nominal lumen battery pack (Noncompliant with CA T20)
	CAS Center air slots (air removal)	33L 3300 lumens	347 347V[2]	EZB eldoLED dims to 0.1% (0-10 volt dimming)	LP835 3500 K, 82CRI	N80 nLight with 80% lumen management	EL14L 1400 nominal lumen battery pack (Noncompliant with CA T20)
		40L 4000 lumens		GZ1 Dims to 1% (0-10V dimming)[3]	LP840 4000 K, 82CRI	N80EMG nLight with 80% lumen management for use with generator supply EM power	E10WLCP EM Self-Diagnostic battery pack, 10W Constant Power, Certified in CA Title 20 MAEDBS
				GZ10 Dims to 10% (0-10V dimming)[3]	LP850 5000 K, 82CRI	N100 nLight without lumen management	CP Chicago plenum
				EDB eldoLED DALI		N100EMG nLight without lumen management for use with generator supply EM power	BAA Buy America(n) Act Compliant
				SLD Step-level dimming			
				EXA1 Dims to 1%, XPoint wireless enabled			
				EXAB Dims to dark, XPoint wireless enabled			

Provide for EM lights only

Accessories: *Order as separate catalog number.*

DGA22	Drywall ceiling adaptor , unit installation
2X2SMKSHP PAF	Multi-Use Surface Mount Kit 2X2 Post-Paint

Notes

1 Approximate lumen output.
2 Not available with EL battery packs or SLD driver.
3 GZ1 and GZ10 not available with any Control or Sensor options
4 Not available with N80, N80EMG, N100, or N100EMG.
5 Gateway not included. Requires on-site commissioning. Visit www.lightingcontrols.com/XPointWireless for more information.
6 nLight access limitations with EZB.
7 nLight EMG option requires a connection to existing nLight network. Power is provided from a separate N80 or N100 enabled fixture.

Performance Data

Lumen Package	Lumens	Input Watts	LPW
20L LP830	2299	20.1	114
20L LP835	2368	20.1	117
20L LP840	2415	20.1	120
20L LP850	2464	20.1	122
33L LP830	4138	37.0	112
33L LP835	4262	37.0	115
33L LP840	4347	37.0	117
33L LP850	4478	37.0	121
40L LP830	4699	41.4	114
40L LP835	4840	41.4	117
40L LP840	4937	41.4	119
40L LP850	5036	41.4	122

How to Estimate Delivered Lumens in Emergency Mode
Use the formula below to estimate the delivered lumens in emergency mode.
Delivered Lumens = 1.25 x P x LPW
P = Ouput power of emergency driver. P = 10W for E10WLCP option.
LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.
LPW = Lumen per watt rating of the luminaire. LPW information available in Performance Data section.

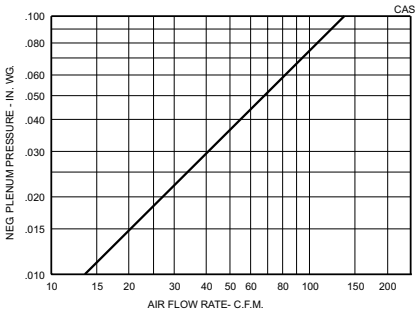
nLight® Control Accessories:
Order as separate catalog number. Visit www.sensorswitch.com/nLight for complete listing of nLight controls.

WallPod stations	Model number	Occupancy sensors	Model number
On/Off	nPODM [color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 / nCM PDT 9
On/Off & Raise/Lower	nPODM DX [color]	Large motion 360°, ceiling (PIR / dual tech)	nCM 10 / nCM PDT 10
Graphic Touchscreen	nPOD GFX	Wall switch with raise/lower	nWSXPDTLVDX
Photocell controls	**Model number**	**Cat-5 cable bundles (plenum rated)**	**Model number**
On/Off & Dimming	nCM ADCX	10', 15 pieces per bundle	CAT5 10FT
		30', 15 pieces per bundle	CAT5 30FT

COMMERCIAL INDOOR: One Lithonia Way Conyers, GA 30012 Phone: 800-705-SERV (7378) www.lithonia.com
 Rev. 04/29/21

2RTL Volumetric Recessed Lighting 2'x2'

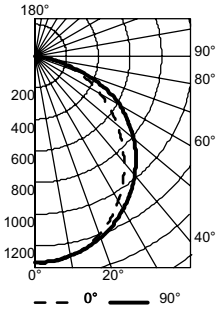
RTL with Air Handling



L2

PHOTOMETRICS

2RTL2 33L LP835, 3,558 delivered lumens, test no. LTL25813P5, tested in accordance to IESNA LM-79.



CP Summary

	0°	90
0°	1302	1302
5°	1306	1299
15°	1250	1256
25°	1133	1173
35°	970	1052
45°	779	903
55°	577	720
65°	378	493
75°	185	194
85°	31	14
90	0	0

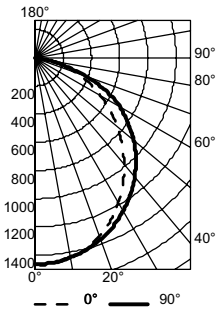
Coefficients of Utilization

RCR	pf 80% pc 70%	50%	30%	pf 20% pc 70%	50%	30%	10%	pf 50% pc 70%	50%	30%	10%
0	119	119	119	116	116	116		111	111	111	
1	109	105	100	102	99	95		98	95	92	
2	99	91	85	89	83	78		86	81	76	
3	91	80	72	79	71	65		76	69	64	
4	83	71	62	70	62	55		67	60	55	
5	76	64	55	62	54	48		60	53	47	
6	70	57	48	56	48	42		54	47	41	
7	65	52	43	51	43	37		50	42	37	
8	61	47	39	47	39	33		45	38	33	
9	57	43	35	43	35	30		42	35	30	
10	53	40	32	40	32	27		39	32	27	

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1003	28.2	28.2
0° - 40°	1633	45.9	45.9
0° - 60°	2863	80.5	80.5
0° - 90°	3558	100.0	100.0
90° - 120°	0	0.0	0.0
90° - 130°	0	0.0	0.0
90° - 150°	0	0.0	0.0
90° - 180°	0	0.0	0.0
0° - 180°	3558	100.0	100.0

2RTL2 40L LP835, 3,991 delivered lumens, test no. LTL25813P10, tested in accordance to IESNA LM-79.



CP Summary

	0°	90
0°	1461	1461
5°	1465	1457
15°	1403	1409
25°	1271	1316
35°	1088	1181
45°	874	1013
55°	648	807
65°	424	553
75°	208	218
85°	34	16
90	0	0

Coefficients of Utilization

RCR	pf 80% pc 70%	50%	30%	pf 20% pc 70%	50%	30%	10%	pf 50% pc 70%	50%	30%	10%
0	119	119	119	116	116	116		111	111	111	
1	109	105	100	102	99	95		98	95	92	
2	99	91	85	89	83	78		86	81	76	
3	91	80	72	79	71	65		76	69	64	
4	83	71	62	70	62	55		67	60	55	
5	76	64	55	62	54	48		60	53	47	
6	70	57	48	56	48	42		54	47	41	
7	65	52	43	51	43	37		50	42	37	
8	61	47	39	47	39	33		45	38	33	
9	57	43	35	43	35	30		42	35	30	
10	53	40	32	40	32	27		39	32	27	

Zonal Lumen Summary

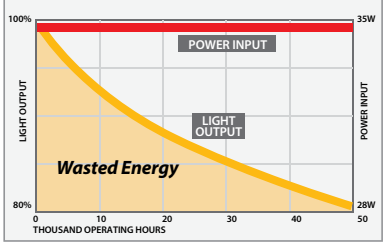
Zone	Lumens	% Lamp	% Fixture
0° - 30°	1125	28.2	28.2
0° - 40°	1832	45.9	45.9
0° - 60°	3212	80.5	80.5
0° - 90°	3991	100.0	100.0
90° - 120°	0	0.0	0.0
90° - 130°	0	0.0	0.0
90° - 150°	0	0.0	0.0
90° - 180°	0	0.0	0.0
0° - 180°	3991	100.0	100.0

Constant Lumen Management

Enabled by the embedded nLight control, the RTL actively tracks its run-time and manages its light source such that constant lumen output is maintained over the system life. Referred to as lumen management, this feature eliminates the energy waste created by the traditional practice of over-lighting.

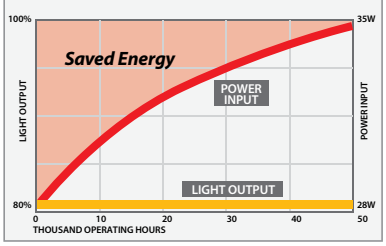
Without Lumen Management

Energy is wasted and light level is inconsistent.



With Lumen Management

Energy is saved and light level remains consistent.



MINI ECHO PENDANT

L3 TECH LIGHTING

PRODUCT FEATURES

- Die-cast aluminum body
- Geometrically striking design and detail draws the eye in
- Available in two contemporary finishes, Chrome and Satin Nickel
- Optical grade pressed glass lens diffuses light beautifully
- Fully dimmable LED creates the desired ambiance in your special space
- Protected by a 1-year warranty

Approved Alternate Manufacturers:
Bruck Rome Series
Stone Lighting Doppio Series

LAMPING

Includes low-voltage, 50 watt halogen bi-pin lamp or 6 watt, 360.7 delivered lumen 90 CRI 3000K, replaceable LED module. Dimmable with low-voltage or magnetic dimmer (based on transformer). Ships with six feet of field-cuttable cable.

Smoke

Clear | Smoke | Steel Blue

ORDERING INFORMATION

700	SYSTEM	ECP	COLOR	FINISH	LAMP	
	FJ FREEJACK		C CLEAR	Z ANTIQUE BRONZE		12 VOLT HALOGEN (T20)
	MP MONOPOINT		S SMOKE	C CHROME	-24	24 VOLT HALOGEN
	MO MONORAIL		U STEEL BLUE	S SATIN NICKEL	-LEDS930	12 VOLT LED 90 CRI 3000K (T20/T24)
					-24	24 VOLT HALOGEN

Note: MP includes 4" Round Flush Canopy.Note: MP includes 4 Round Flush Canopy.
Chrome not offered on Monorail & Two~Circuit Monorail.

700 _____ ECP _____ _____ _____

JOB NAME _____

NOTES _____

7400 Linder Avenue, Skokie, IL 60077
T 847.410.4400 | F 847.410.4500 | techlighting.com

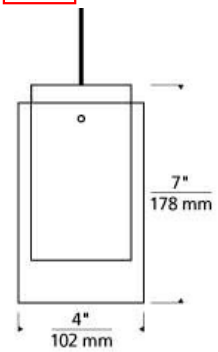
MINI ECHO PENDANT

L3

TECH LIGHTING

SPECIFICATIONS

HARDWARE MATERIAL	Metal
SHADE MATERIAL	Glass
NET WEIGHT	1.3 lbs
HEIGHT	7in
WIDTH	4in
LENGTH	4in
UP LIGHT / DOWN LIGHT / BOTH?	
WET LISTED	
DAMP LISTED	
DRY LISTED	
MIN. HANGING HEIGHT	13.5in
MAX HANGING HEIGHT	79.5in
SLOPED CEILING ADAPTABLE?	
GENERAL LISTING	
INCLUDES	



LAMPING SPECIFICATIONS

	LED LAMP	INTEGRATED LED	NON LED	NO LAMP
DELIVERED LUMENS	300			
WATTS	8		50	
MAX WATTAGE PER BULB	50W		50W	
INPUT VOLTAGE	12V 120V		12V 120V	
DIMMING TYPE*	ELV		ELV	
CCT	3000K		3000K	
CRI	90 CRI			
LED LIFETIME				
L70				
AVERAGE BULB HOURS	25000		2000	
FIELD SERVICEABLE LED				
LAMP BASE	GY 6.35		GY 6.35	
LAMP SHAPE	T4		T4	
LAMP INCLUDED?	Y		Y	
WARRANTY**	1 Year		1 Year	

* Dimming information available at www.techlighting.com/Downloads#dimming
** Visit techlighting.com for specific warranty limitations and details.

T20 / T24 INFORMATION

	Integrated LED	Replacement LED Lamp	No Lamp *
This product can be used to comply with California Building Energy Efficiency Standards 2016 **Title 24** Part 6.		Yes	
This product can be used to comply with California Appliance Efficiency Standards 2016 **Title 20** and may be shipped to and sold in California.		Yes	

* If a light fixture or component does not include a lamp or light source, it is the responsibility of the customer to select a lamp that meets the T24 and T20 requirements.

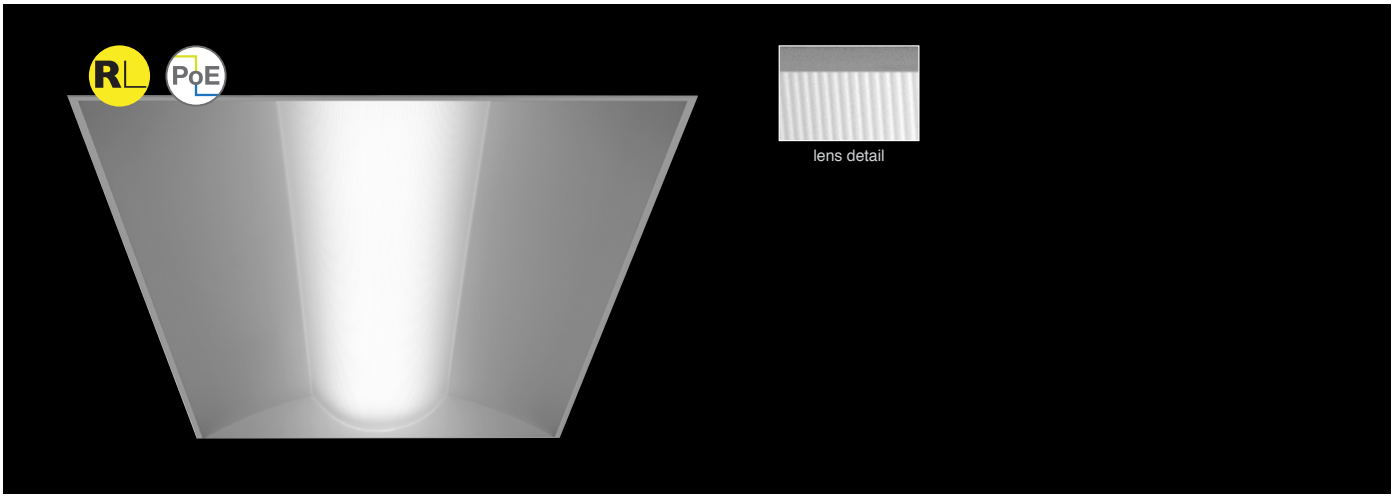
7400 Linder Avenue, Skokie, IL 60077
T 847.410.4400 | F 847.410.4500 | techlighting.com

Amica™ 2x4

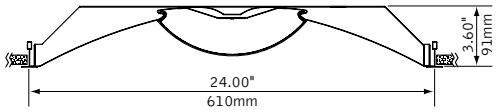
LED

L4A

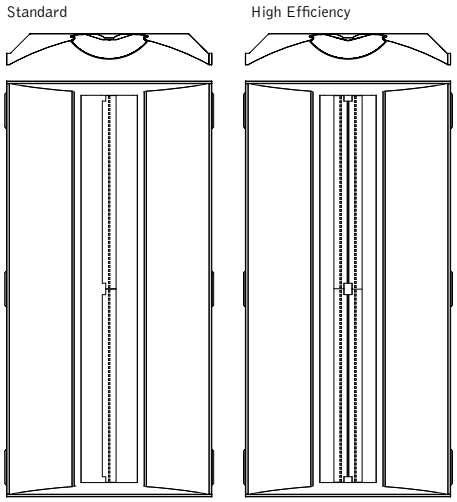
FOCAL POINT



DIMENSIONAL DATA



led options



FEATURES

Architectural recessed LED luminaire.

Sweeping curves and classic lines complement architecture.

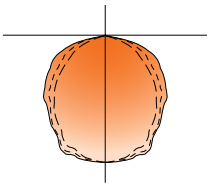
Amica's center ribbed diffuser masks LED brightness and image to create even illumination.

Amica features a shallow 3.6" housing depth which flies under the radar of most plenum obstructions.

PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

PERFORMANCE



High Performance
5000 Lumens (5000LH)

Delivered Lumens: 5000lm

Total System Watts: 44W

PRODUCT OVERVIEW

Lumen Output:	4000-6000lm
Wattage:	37-54W
LPW:	102-118
SDCM:	3

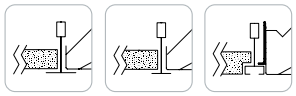
Photometric performance is measured in accordance with IESNA LM-79. Visit focalpointlights.com for complete photometric data. Visit designlights.org/QPL for model specifics.

fixture: project:

MOUNTING INFORMATION

grid

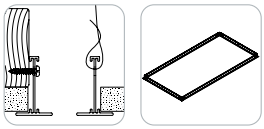
for lay–in grid, specify G1, G2 or G3.



g1 15/16" g2 9/16" g3 slot 9/16"

drywall frame kit

specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.

cut out dimensions:
2': Min: 24.25" Max: 24.563"
4': Min: 48.25" Max: 48.563"

SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 3000K, 3500K or 4000K with CRI>80, 3 SDCM. 0-10V dimming driver standard. LED modules and drivers are replaceable from below.

Construction

One piece 20 Ga. steel reflector and housing. Side access 20 Ga. steel ballast compartment. Positional brackets supplied as standard. Unit weight: 25 lbs.

Optic

20 Ga. steel reflectors finished in matte satin white powder coat. .095" thick frosted white acrylic lamp diffusers with linear micro–prism pattern.

Electrical

Standard 120-277V driver includes 0-10V analog dimming. Power factor > .9. Optional EcoSystem or forward phase dimming drivers from Lutron available. PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

Emergency Battery

Bodine BSL310–CAN Emergency output—10 watts for 90 minutes. Grid and Drywall Frame kit mounting only.

Labels

UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a 5-stage pre–treatment. Optional Matte Satin White with anti–microbial coating provides 99.99% protection against a broad spectrum of micro–organisms.

Lumen Maintenance

Reported: L90 at >61,000 hours Calculated: L90 at 114,000 hours

Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Warranty

LED system rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Delivered Lumens		Tested System Watts	LPW
4000 Lumens	4000L	37	108
	4000LH	34	118
4500 Lumens	4500L	43	105
	4500LH	39	115
5000 Lumens	5000L	48	104
	5000LH	44	114
5500 Lumens	5500L	54	102
	5500LH	48	115
6000 Lumens	6000LH	54	111

Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%

Focal Point LLC reserves the right to change specifications for product improvement without notification.

L4A

ORDERING

Luminaire Series		**FAML**
Amica LED	FAML	
Nominal Size		**24**
2' x 4'	24	
Shielding		**ACR**
Radial Acrylic Diffuser	ACR	
Lumen Output		
Standard		
4000 Lumens	4000L	
4500 Lumens	4500L	
5000 Lumens	5000L	
5500 Lumens	5500L	
High Efficiency		
4000 Lumens	4000LH	
4500 Lumens	4500LH	
5000 Lumens	5000LH	
5500 Lumens	5500LH	
6000 Lumens	6000LH	
Color Temperature		
3000K, 80+ CRI	30K	
3500K, 80+ CRI	35K	
4000K, 80+CRI	40K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
120 Volt	120	
277 Volt	277	
UNV Volt	UNV	
Low Voltage	LV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming (5000 Lumens and higher: (2) drivers supplied, (2) EcoSystem addresses consumed)	LD1	
Low Voltage, PoE compatible (No driver. Not available with EM or EC. LV Voltage only.)	LVN	
Lutron Hi-Lume - Forward Phase - 1% Dimming (5000 Lumens and higher: (2) drivers supplied, (2) loads consumed (120 only) (Grid and drywall mounting only)	LTE	
Step Dimming (Grid and drywall mounting only)	SD5	
DALI - 1% Dimming (Consult factory)	D11	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
15/16" Grid	G1	
9/16" Grid	G2	
9/16" Slot Tee	G3	
Drywall Frame Kit (Cut out dimensions: Min: 24.25"/Max: 24.563" Min: 48.25"/Max: 48.563")	F	
Surface Mount	SM	
Factory Options		
Air Return (Overall height for luminaire with Air Return is 4.25")	AR	
Chicago Plenum	CP	
Emergency Battery Pack with Integral Test Switch	EM	
6' New York City Flex Whip	FNY	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	

Provide for EM lights only

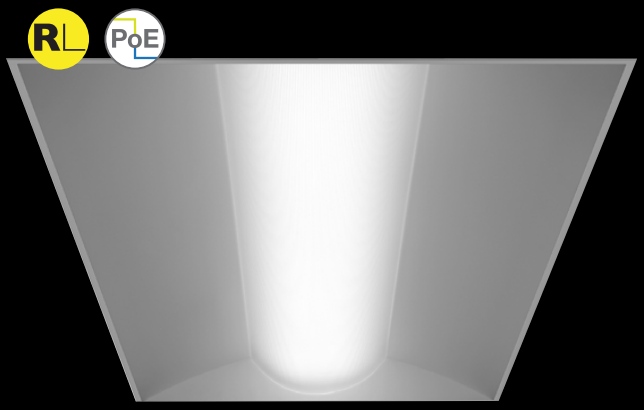
QS 5/10 DAY* Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

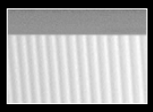
Amica™ 2x4

LED

L4B

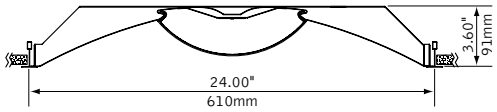
FOCAL POINT



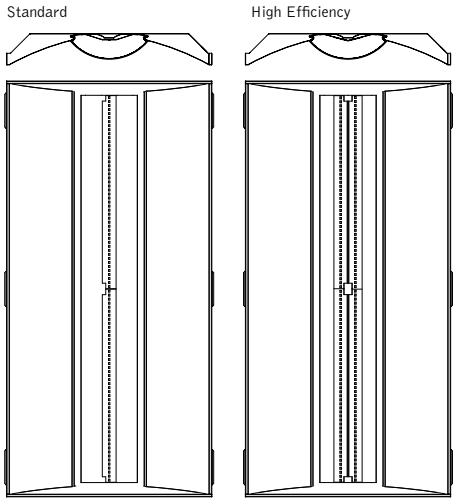


lens detail

DIMENSIONAL DATA



led options



FEATURES

Architectural recessed LED luminaire.

Sweeping curves and classic lines complement architecture.

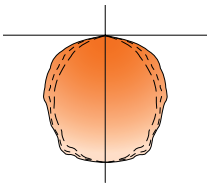
Amica's center ribbed diffuser masks LED brightness and image to create even illumination.

Amica features a shallow 3.6" housing depth which flies under the radar of most plenum obstructions.

PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

PERFORMANCE



High Performance
5000 Lumens (5000LH)

Delivered Lumens: 5000lm

Total System Watts: 44W

PRODUCT OVERVIEW

Lumen Output:	4000-6000lm
Wattage:	37-54W
LPW:	102-118
SDCM:	3

Photometric performance is measured in accordance with IESNA LM-79. Visit focalpointlights.com for complete photometric data. Visit designlights.org/QPL for model specifics.

fixture: project:

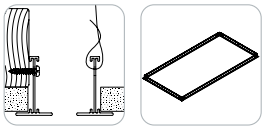
MOUNTING INFORMATION

grid

for lay–in grid, specify G1, G2 or G3.

drywall frame kit

specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.

cut out dimensions:
2': Min: 24.25" Max: 24.563"
4': Min: 48.25" Max: 48.563"

SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 3000K, 3500K or 4000K with CRI>80, 3 SDCM. 0-10V dimming driver standard. LED modules and drivers are replaceable from below.

Construction

One piece 20 Ga. steel reflector and housing. Side access 20 Ga. steel ballast compartment. Positional brackets supplied as standard. Unit weight: 25 lbs.

Optic

20 Ga. steel reflectors finished in matte satin white powder coat. .095" thick frosted white acrylic lamp diffusers with linear micro–prism pattern.

Electrical

Standard 120-277V driver includes 0-10V analog dimming. Power factor > .9. Optional EcoSystem or forward phase dimming drivers from Lutron available. PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

Emergency Battery

Bodine BSL310–CAN. Emergency output—10 watts for 90 minutes. Grid and Drywall Frame kit mounting only.

Labels

UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a 5-stage pre–treatment. Optional Matte Satin White with anti–microbial coating provides 99.99% protection against a broad spectrum of micro–organisms.

Lumen Maintenance

Reported: L90 at >61,000 hours Calculated: L90 at 114,000 hours

Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Warranty

LED system rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Delivered Lumens		Tested System Watts	LPW
4000 Lumens	4000L	37	108
	4000LH	34	118
4500 Lumens	4500L	43	105
	4500LH	39	115
5000 Lumens	5000L	48	104
	5000LH	44	114
5500 Lumens	5500L	54	102
	5500LH	48	115
6000 Lumens	6000LH	54	111

Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%

Focal Point LLC reserves the right to change specifications for product improvement without notification.

Provide for EM option only

L4B

ORDERING

Luminaire Series		**FAML**
Amica LED	FAML	
Nominal Size		**24**
2' x 4'	24	
Shielding		**ACR**
Radial Acrylic Diffuser	ACR	
Lumen Output		
Standard		
4000 Lumens	4000L	
4500 Lumens	4500L	
5000 Lumens	5000L	
5500 Lumens	5500L	
High Efficiency		
4000 Lumens	4000LH	
4500 Lumens	4500LH	
5000 Lumens	5000LH	
5500 Lumens	5500LH	
6000 Lumens	6000LH	
Color Temperature		
3000K, 80+ CRI	30K	
3500K, 80+ CRI	35K	
4000K, 80+CRI	40K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
120 Volt	120	
277 Volt	277	
UNV Volt	UNV	
Low Voltage	LV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming 5000 Lumens and higher: (2) drivers supplied, (2) EcoSystem addresses consumed	LD1	
Low Voltage, PoE compatible (No driver. Not available with EM or EC. LV Voltage only.)	LVN	
Lutron Hi-Lume - Forward Phase - 1% Dimming 5000 Lumens and higher: (2) drivers supplied, (2) loads consumed (120 only) (Grid and drywall mounting only)	LTE	
Step Dimming (Grid and drywall mounting only)	SD5	
DALI - 1% Dimming (Consult factory)	D11	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
15/16" Grid	G1	
9/16" Grid	G2	
9/16" Slot Tee	G3	
Drywall Frame Kit (Cut out dimensions: Min: 24.25"/Max: 24.563" Min: 48.25"/Max: 48.563")	F	
Surface Mount	SM	
Factory Options		
Air Return (Overall height for luminaire with Air Return is 4.25")	AR	
Chicago Plenum	CP	
Emergency Battery Pack with Integral Test Switch	EM	
New York City Flex Whip	FNY	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	

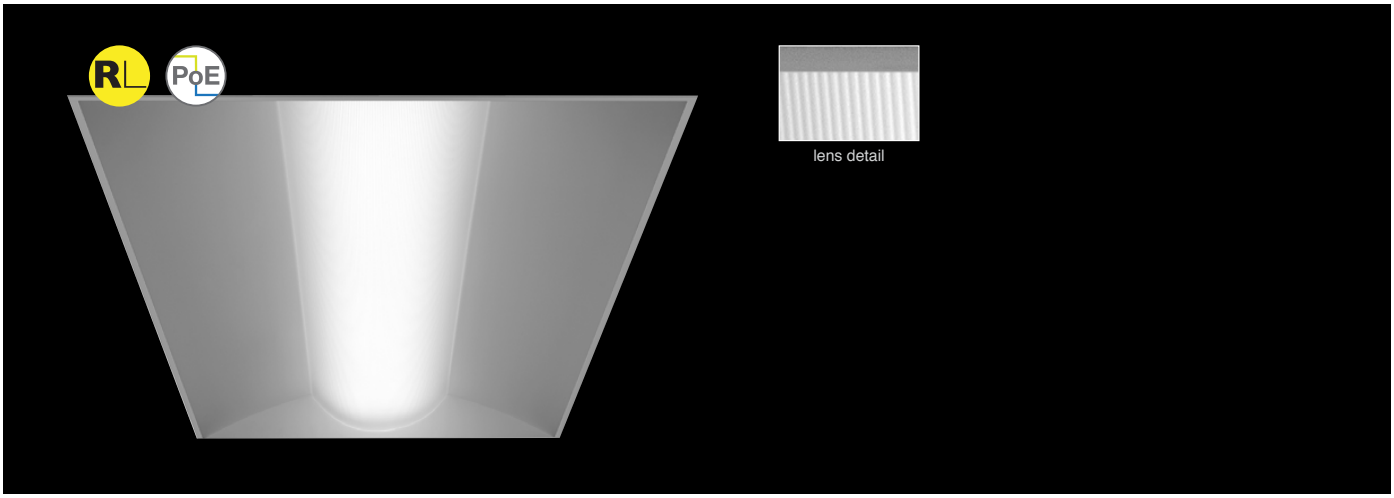
QS 5/10 DAY* Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

Amica™ 2x4

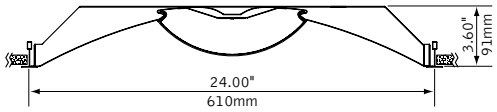
LED

L4C

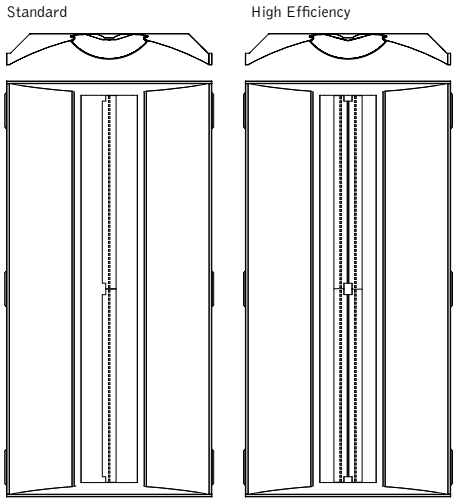
FOCAL POINT



DIMENSIONAL DATA



led options



FEATURES

Architectural recessed LED luminaire.

Sweeping curves and classic lines complement architecture.

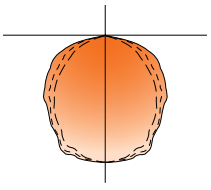
Amica's center ribbed diffuser masks LED brightness and image to create even illumination.

Amica features a shallow 3.6" housing depth which flies under the radar of most plenum obstructions.

PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

PERFORMANCE



High Performance
5000 Lumens (5000LH)

Delivered Lumens: 5000lm

Total System Watts: 44W

PRODUCT OVERVIEW

Lumen Output:	4000-6000lm
Wattage:	37-54W
LPW:	102-118
SDCM:	3

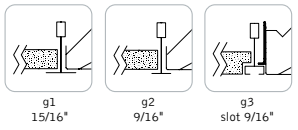
Photometric performance is measured in accordance with IESNA LM-79. Visit focalpointlights.com for complete photometric data. Visit designlights.org/QPL for model specifics.

fixture: project:

MOUNTING INFORMATION

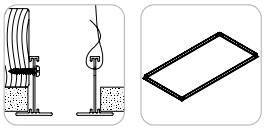
grid

for lay–in grid, specify G1, G2 or G3.



drywall frame kit

specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.

cut out dimensions:
2': Min: 24.25" Max: 24.563"
4': Min: 48.25" Max: 48.563"

SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 3000K, 3500K or 4000K with CRI>80, 3 SDCM. 0-10V dimming driver standard. LED modules and drivers are replaceable from below.

Construction

One piece 20 Ga. steel reflector and housing. Side access 20 Ga. steel ballast compartment. Positional brackets supplied as standard. Unit weight: 25 lbs.

Optic

20 Ga. steel reflectors finished in matte satin white powder coat. .095" thick frosted white acrylic lamp diffusers with linear micro–prism pattern.

Electrical

Standard 120-277V driver includes 0-10V analog dimming. Power factor > .9. Optional EcoSystem or forward phase dimming drivers from Lutron available. PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

Emergency Battery

Bodine BSL310–CAN Emergency output—10 watts for 90 minutes. Grid and Drywall Frame kit mounting only.

Labels

UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a 5-stage pre–treatment. Optional Matte Satin White with anti–microbial coating provides 99.99% protection against a broad spectrum of micro–organisms.

Lumen Maintenance

Reported: L90 at >61,000 hours Calculated: L90 at 114,000 hours

Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Warranty

LED system rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Delivered Lumens		Tested System Watts	LPW
4000 Lumens	4000L	37	108
	4000LH	34	118
4500 Lumens	4500L	43	105
	4500LH	39	115
5000 Lumens	5000L	48	104
	5000LH	44	114
5500 Lumens	5500L	54	102
	5500LH	48	115
6000 Lumens	6000LH	54	111

Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%

Focal Point LLC reserves the right to change specifications for product improvement without notification.

L4C

ORDERING

Luminaire Series		**FAML**
Amica LED	FAML	
Nominal Size		**24**
2' x 4'	24	
Shielding		**ACR**
Radial Acrylic Diffuser	ACR	
Lumen Output		
Standard		
4000 Lumens	4000L	
4500 Lumens	4500L	
5000 Lumens	5000L	
5500 Lumens	5500L	
High Efficiency		
4000 Lumens	4000LH	
4500 Lumens	4500LH	
5000 Lumens	5000LH	
5500 Lumens	5500LH	
6000 Lumens	6000LH	
Color Temperature		
3000K, 80+ CRI	30K	
3500K, 80+ CRI	35K	
4000K, 80+CRI	40K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
120 Volt	120	
277 Volt	277	
UNV Volt	UNV	
Low Voltage	LV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming 5000 Lumens and higher: (2) drivers supplied, (2) EcoSystem addresses consumed	LD1	
Low Voltage, PoE compatible (No driver. Not available with EM or EC. LV Voltage only.)	LVN	
Lutron Hi-Lume - Forward Phase - 1% Dimming 5000 Lumens and higher: (2) drivers supplied, (2) loads consumed (120 only) (Grid and drywall mounting only)	LTE	
Step Dimming (Grid and drywall mounting only)	SD5	
DALI - 1% Dimming (Consult factory)	D11	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
15/16" Grid	G1	
9/16" Grid	G2	
9/16" Slot Tee	G3	
Drywall Frame Kit (Cut out dimensions: Min: 24.25"/Max: 24.563" Min: 48.25"/Max: 48.563")	F	
Surface Mount	SM	
Factory Options		
Air Return (Overall height for luminaire with Air Return is 4.25")	AR	
Chicago Plenum	CP	
Emergency Battery Pack with Integral Test Switch	EM	
6' New York City Flex Whip	FNY	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	

AS INDICATED ON PLAN

QS 5/10 DAY*

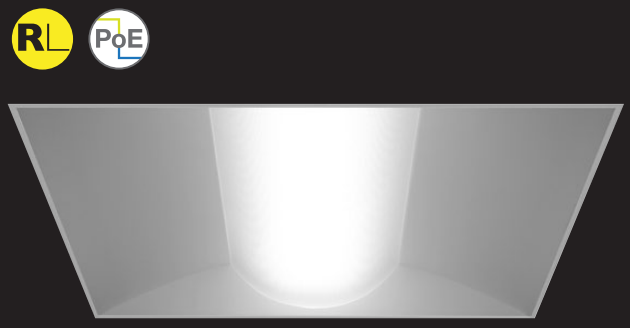
Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

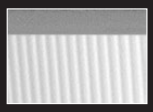
Amica™ 2x2

LED

L5A

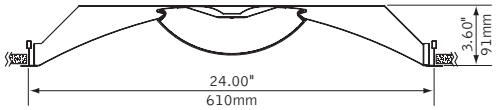
FOCAL POINT



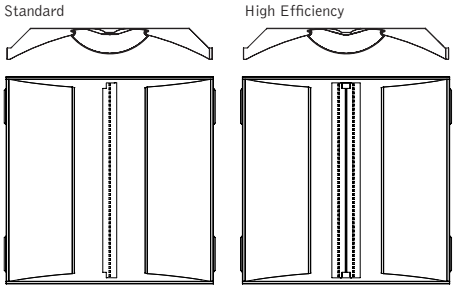


lens detail

DIMENSIONAL DATA



led options



FEATURES

Architectural recessed LED luminaire.

Sweeping curves and classic lines complement architecture.

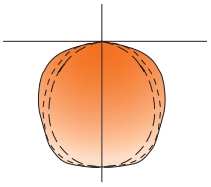
Amica's center ribbed diffuser masks LED brightness and image to create even illumination.

Amica features a shallow 3.6" housing depth which flies under the radar of most plenum obstructions.

PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

PERFORMANCE



High Performance
2500 Lumens (2500LH)

Delivered Lumens: 2500lm

Total System Watts: 24W

PRODUCT OVERVIEW

Lumen Output:	2000-4000lm
Wattage:	19-41W
LPW:	94-105
SDCM:	3

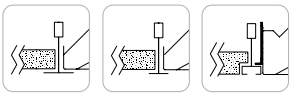
Photometric performance is measured in accordance with IESNA LM-79. Visit focalpointlights.com for complete photometric data. Visit designlights.org/QPL for model specifics.

fixture: project:

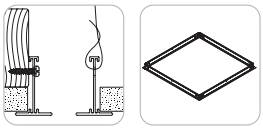
L5A

MOUNTING INFORMATION

grid
for lay–in grid, specify G1, G2 or G3.



drywall frame kit
specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.

cut out dimensions:
2': Min: 24.25"
Max: 24.563"

SPECIFICATIONS

LED System
Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 3000K, 3500K or 4000K with CRI>80, 3 SDCM. 0-10V dimming driver standard. LED modules and drivers are replaceable from below.

Construction
One piece 20 Ga. steel reflector and housing. Side access 20 Ga. steel ballast compartment. Positional brackets supplied as standard. Unit weight: 17 lbs.

Optic
20 Ga. steel reflectors finished in matte satin white powder coat. .095" thick frosted white acrylic lamp diffusers with linear micro–prism pattern.

Electrical
Standard 120-277V driver includes 0-10V analog dimming. Power factor > .9. Optional Eco-System or forward phase dimming drivers from Lutron available. PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

Emergency Battery
Bodine BSL310–CAN. Emergency output–10 watts for 90 minutes. Grid and Drywall Frame kit mounting only.

Labels
UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish
Polyester powder coat applied over a 5-stage pre–treatment. Optional Matte Satin White with anti–microbial coating provides 99.99% protection against a broad spectrum of micro–organisms.

Lumen Maintenance
Reported: L90 at >61,000 hours Calculated: L90 at 114,000 hours
Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional

Reliability
At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Warranty
LED system rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Delivered Lumens		Tested System Watts	LPW
2000 Lumens	2000L	19	105
2500 Lumens	2500L	26	96
	2500LH	24	104
3000 Lumens	3000L	32	94
	3000LH	29	103
3500 Lumens	3500LH	35	100
4000 Lumens	4000LH	41	98

Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%

Focal Point LLC reserves the right to change specifications for product improvement without notification.

ORDERING

Luminaire Series		**FAML**
Amica LED	FAML	
Nominal Size		**22**
2' x 2'	22	
Shielding		**ACR**
Radial Acrylic Diffuser	ACR	
Lumen Output		
Standard		
2000 Lumens	2000L	
2500 Lumens	2500L	
3000 Lumens	3000L	
High Efficiency		
2500 Lumens	2500LH	
3000 Lumens	3000LH	
3500 Lumens	3500LH	
4000 Lumens	4000LH	
Color Temperature		
3000K, 80+ CRI	30K	
3500K, 80+ CRI	35K	
4000K, 80+CRI	40K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
120 Volt	120	
277 Volt	277	
UNV Volt	UNV	
Low Voltage	LV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Low Voltage, PoE compatible (No driver. Not available with EM or EC. LV Voltage only.)	LVN	
Lutron Hi-Lume - Forward Phase - 1% Dimming (120 only) (Grid and drywall mounting only)	LTE	
Step Dimming (Grid and drywall mounting only)	SD5	
DALI - 1% Dimming (Consult factory)	D11	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
15/16" Grid	G1	
9/16" Grid	G2	
9/16" Slot Tee	G3	
Drywall Frame Kit (Cut out dimensions: Min: 24.25'/Max: 24.563')	F	
Surface Mount	SM	
Factory Options		
Air Return (Overall height for luminaire with Air Return is 4.25')	AR	
Chicago Plenum	CP	
Emergency Battery Pack with Integral Test Switch	EM	
6' New York City Flex Whip	FNY	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	
Matte Satin White with Anti–Microbial Coating	WHA	

Provide for EM lights only

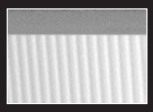
QS 5/10 DAY* Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

Amica™ 2x2

LED

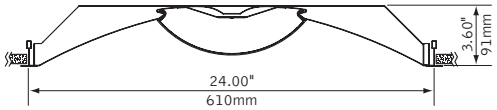
L5B

FOCAL POINT

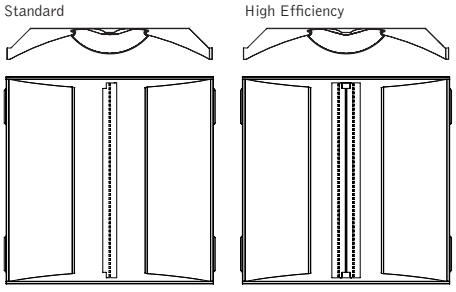


lens detail

DIMENSIONAL DATA



led options



FEATURES

Architectural recessed LED luminaire.

Sweeping curves and classic lines complement architecture.

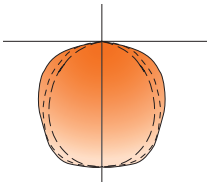
Amica's center ribbed diffuser masks LED brightness and image to create even illumination.

Amica features a shallow 3.6" housing depth which flies under the radar of most plenum obstructions.

PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

PERFORMANCE



High Performance
2500 Lumens (2500LH)

Delivered Lumens: 2500lm

Total System Watts: 24W

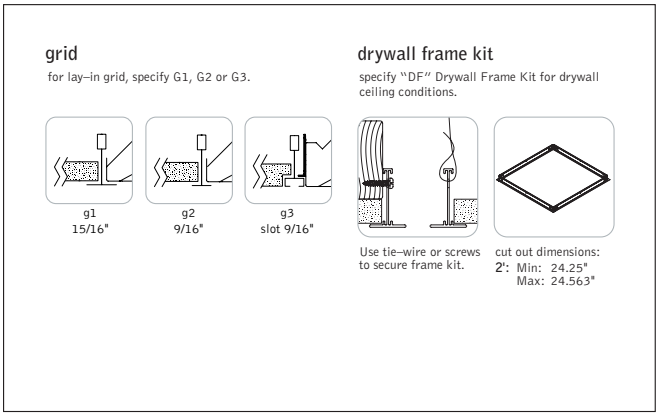
PRODUCT OVERVIEW

Lumen Output:	2000-4000lm
Wattage:	19-41W
LPW:	94-105
SDCM:	3

Photometric performance is measured in accordance with IESNA LM-79. Visit focalpointlights.com for complete photometric data. Visit designlights.org/QPL for model specifics.

fixture: project:

MOUNTING INFORMATION



SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 3000K, 3500K or 4000K with CRI>80, 3 SDCM. 0-10V dimming driver standard. LED modules and drivers are replaceable from below.

Construction

One piece 20 Ga. steel reflector and housing. Side access 20 Ga. steel ballast compartment. Positional brackets supplied as standard. Unit weight: 17 lbs.

Optic

20 Ga. steel reflectors finished in matte satin white powder coat. .095" thick frosted white acrylic lamp diffusers with linear micro–prism pattern.

Electrical

Standard 120-277V driver includes 0-10V analog dimming. Power factor > .9. Optional Eco-System or forward phase dimming drivers from Lutron available. PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

Emergency Battery

Bodine BSL310–CAN. Emergency output—10 watts for 90 minutes. Grid and Drywall Frame kit mounting only.

Labels

UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a 5-stage pre–treatment. Optional Matte Satin White with anti–microbial coating provides 99.99% protection against a broad spectrum of micro–organisms.

Lumen Maintenance

Reported: L90 at >61,000 hours Calculated: L90 at 114,000 hours

Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Warranty

LED system rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Delivered Lumens		Tested System Watts	LPW
2000 Lumens	2000L	19	105
2500 Lumens	2500L	26	96
	2500LH	24	104
3000 Lumens	3000L	32	94
	3000LH	29	103
3500 Lumens	3500LH	35	100
4000 Lumens	4000LH	41	98

Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%

Focal Point LLC reserves the right to change specifications for product improvement without notification.

L5B

ORDERING

Luminaire Series		**FAML**
Amica LED	FAML	
Nominal Size		**22**
2' x 2'	22	
Shielding		**ACR**
Radial Acrylic Diffuser	ACR	
Lumen Output		
Standard		
2000 Lumens	2000L	
2500 Lumens	2500L	
3000 Lumens	3000L	
High Efficiency		
2500 Lumens	2500LH	
3000 Lumens	3000LH	
3500 Lumens	3500LH	
4000 Lumens	4000LH	
Color Temperature		
3000K, 80+ CRI	30K	
3500K, 80+ CRI	35K	
4000K, 80+CRI	40K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
120 Volt	120	
277 Volt	277	
UNV Volt	UNV	
Low Voltage	LV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Low Voltage, PoE compatible (No driver. Not available with EM or EC. LV Voltage only.)	LVN	
Lutron Hi-Lume - Forward Phase - 1% Dimming (120 only) (Grid and drywall mounting only)	LTE	
Step Dimming (Grid and drywall mounting only)	SD5	
DALI - 1% Dimming (Consult factory)	D11	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
15/16" Grid	G1	
9/16" Grid	G2	
9/16" Slot Tee	G3	
Drywall Frame Kit (Cut out dimensions: Min: 24.25"/Max: 24.563")	F	
Surface Mount	SM	
Factory Options		
Air Return (Overall height for luminaire with Air Return is 4.25")	AR	
Chicago Plenum	CP	
Emergency Battery Pack with Integral Test Switch	EM	
6' New York City Flex Whip	FNY	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	
Matte Satin White with Anti–Microbial Coating	WHA	

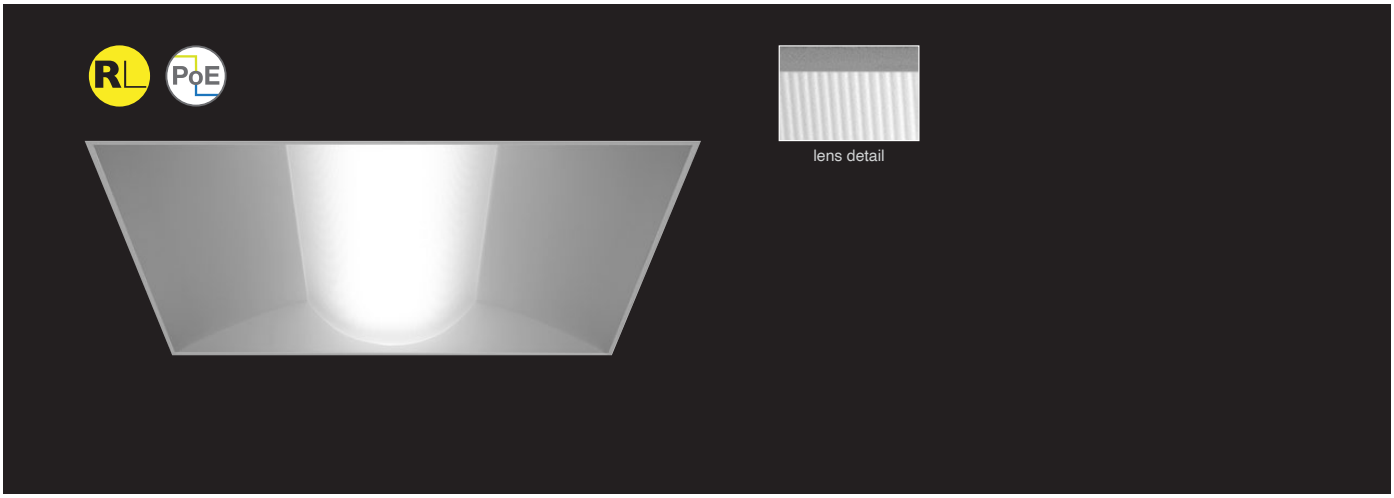
QS 5/10 DAY* Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

Amica™ 2x2

LED

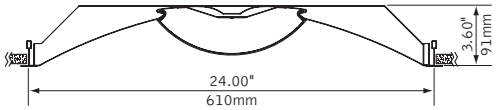
L5C

FOCAL POINT

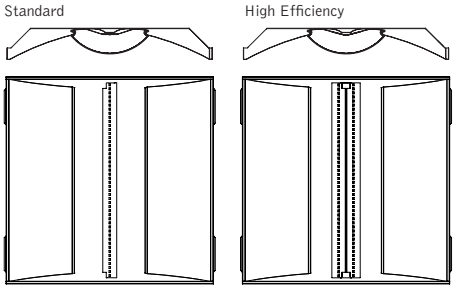


lens detail

DIMENSIONAL DATA



led options



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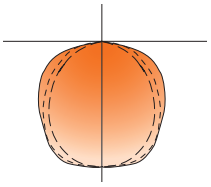
PERFORMANCE



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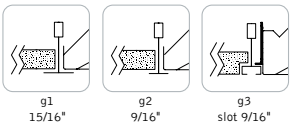
Total System Watts: 24W

Photometric performance is measured in accordance with IESNA LM-79. Visit focalpointlights.com for complete photometric data. Visit designlights.org/QPL for model specifics.

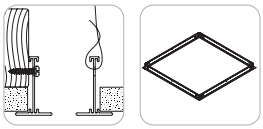
fixture: project:

MOUNTING INFORMATION

grid
for lay–in grid, specify G1, G2 or G3.



drywall frame kit
specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.

cut out dimensions:
2': Min: 24.25"
Max: 24.563"

SPECIFICATIONS

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Polyester powder coat applied over a 5-stage pre–treatment. Optional Matte Satin White with anti–microbial coating provides 99.99% protection against a broad spectrum of micro–organisms.

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Reported: L90 at >61,000 hours Calculated: L90 at 114,000 hours
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L5C

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Amica LED	FAML	
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3000 Lumens	3000L	
High Efficiency		
2500 Lumens	2500LH	
3000 Lumens	3000LH	
3500 Lumens	3500LH	
4000 Lumens	4000LH	
Color Temperature		
3000K, 80+ CRI	30K	
3500K, 80+ CRI	35K	
4000K, 80+CRI	40K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
120 Volt	120	
277 Volt	277	
UNV Volt	UNV	
Low Voltage	LV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Low Voltage, PoE compatible (No driver. Not available with EM or EC. LV Voltage only.)	LVN	
Lutron Hi-Lume - Forward Phase - 1% Dimming (120 only) (Grid and drywall mounting only)	LTE	
Step Dimming (Grid and drywall mounting only)	SD5	
DALI - 1% Dimming (Consult factory)	D11	
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48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
15/16" Grid	G1	
9/16" Grid	G2	
9/16" Slot Tee	G3	
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Surface Mount	SM	
Factory Options		
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Emergency Battery Pack with Integral Test Switch	EM	
6' New York City Flex Whip	FNY	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	
Matte Satin White with Anti–Microbial Coating	WHA	

Provide for EM lights only

QS 5/10 DAY* Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L6A

Acoustic
HP-2 Acoustic Baffle Lit

HP-2 Acoustic Baffle Lit is a high-performing, sound-absorbing LED pendant luminaire with a 2" aperture. It's available in direct and indirect/direct, flush or regressed options. This luminaire offers a sophisticated and convenient way to achieve desired illumination and reverberation levels in open space environments. HP-2 Acoustic contributes towards WELL Sound Absorption SO4 requirements.

Pewter housing shown
Pewter or Slate are standard housing color options; Signal White luminaire finish is standard.

Great Sound Absorption

1.20 NRC — Apparent noise reduction coefficient (NRC) up to 1.20.

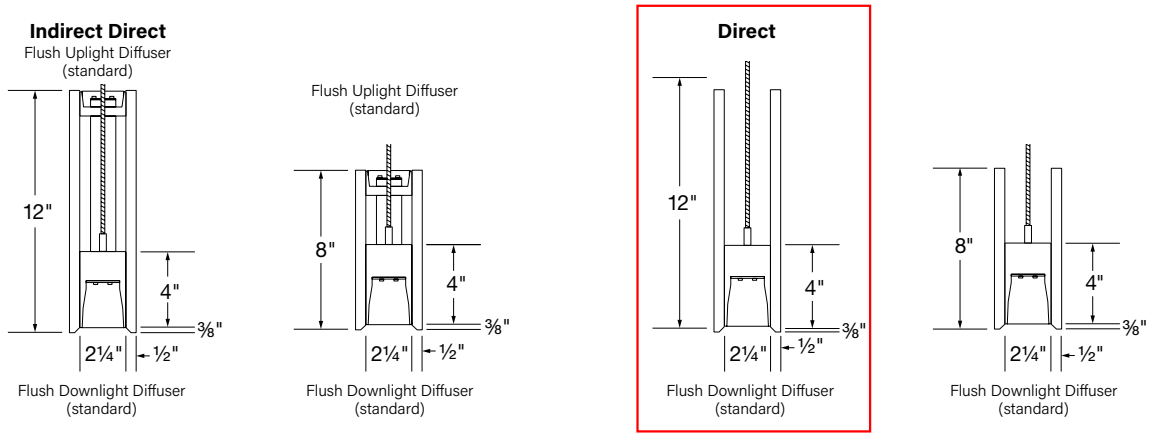
10 Day Shipping

10 Working day — 10-Working day shipping on standard orders. Consult factory for extended acoustic housing color options.

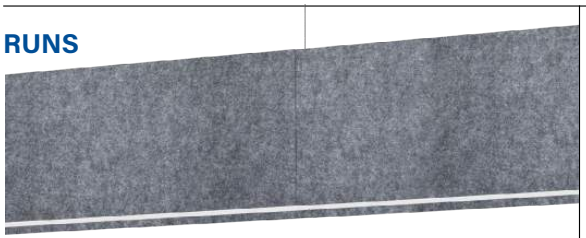
Quality Material

A ASTM — Class A fire resistant material (ASTM E-84); Moisture resistant.

CROSS SECTIONS **Standard body shown. D, I/D, 8", and 12" options also available with regressed body.**



RUNS



Now available in continuous runs and independent section lengths. See page 6 for configurations

COMPLEMENTARY PRODUCT

HP-2 Acoustic Baffle Unlit
Pair with this sound-absorbing and eco-friendly unlit pendant baffle to achieve desired reverberation levels with a consistent aesthetic.

Refer to complementary tech sheet

Industry Best 10 Year LED Warranty
Fine TUNE Generation 7 Option Available
WELL v2

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L6A

Acoustic
HP-2 Acoustic Baffle Lit

BODY TYPE

Platform	Series Name	Luminaire Type	Luminaire Distribution	Total Run
◉ HP - High Performance	◉ 2	◯ P - Pendant ◯ P RG - Pendant Regressed	◯ D - Direct ◯ ID - Indirect Direct	24ft Multiples of 4' and 8' sections, standard

OUTPUT and LED TYPE

Uplight Output ID only	Downlight Output
◯ S - Standard ◯ B - Boosted Standard ◯ H - High ◯ V - Very High ◯ TL - Tailored: _____ lm/ft *	◯ S - Standard (329 lm/ft) ◯ B - Boosted Standard (414 lm/ft) ◯ H - High (625 lm/ft) ◯ V - Very High (804 lm/ft) ◯ TL - Tailored: _____ lm/ft *

* Specify lm/ft of outputs between Standard (S) and Very High (V). Consult factory for tailored lumen output outside of this range.

OUTPUT and LED TYPE

LED CRI/CCT
◯ 830 - 80 CRI min, 3000K
◯ 835 - 80 CRI min, 3500K
◯ 840 - 80 CRI min, 4000K
◯ 930 - 90 CRI min, 3000K
◯ 935 - 90 CRI min, 3500K
◯ 940 - 90 CRI min, 4000K
◯ 8TW - 80 CRI min, Tunable White
◯ 9TW - 90 CRI min, Tunable White

MECHANICAL/OPTICAL OPTIONS

Uplight Option ID only	Downlight Option	Reflector System
◯ F - Flush (standard) ◯ WSO - Widespread Optic ◯ ASY-L - Asymmetric Left ◯ ASY-R - Asymmetric Right	◯ F - Flush (standard) ◯ BG - Bottom Glow ◯ DL - 1" Drop Down Lens ◯ RG-D - Flat Diffuser with 1" Regress [1] ◯ RG-WCB - White Cross Blade Baffle [1] ◯ RG-LHE - Hollowed Ellipse Louver [1] ◯ RG-LHC - Hex Louver [1] ◯ DSO - Downlight Spread Optic [2]	◉ 96 - 96 Low Gloss White

ELECTRICAL OPTIONS

Voltage	Circuiting	Driver Selection
◯ 120 - 120 Voltage ◯ 277 - 277 Voltage ◯ 347 - 347 Voltage	◯ SC - Single Circuit* One single circuit in a run ◯ DC - Dual Circuit* Independent control of up and down separately in an I/D style fixture ◯ MC - Multi Circuit* More than one switch leg or zone (not 'DC' independent control of up and down separately for an I/D style fixture) Factory shop drawings required Battery, Night Light, and Emergency to Generator circuits are in addition to the normal luminaire circuit(s)	**0-10V Driver Options** ◯ FC-10% - 0-10V 10% (standard) [3] ◯ FC-1% - 0-10V 1% [3] ◯ OSR-10% - Osram OTi, 0-10V 10% [3] ◯ OSR-1% - Osram OTi, 0-10V 1% [3] ◯ ELD-10V - EldoLED SOLOdrive, 0-10V 0.1% ◯ 10V-TW - Osram OTi, 0-10V 10% *(Tunable White)* [3] **DALI Driver Options** ◯ FC-DALI - DALI 1% ◯ OSR-DALI - Osram Dexal, 1% ◯ ELD-DALI - EldoLED SOLOdrive, DALI 0.1% ◯ DALI-TW - EldoLED Dual Drive Light Shape, 1% *(Tunable White)* **DMX Driver Options** ◯ FIN-DMX - Finelite DMX 1% *(Tunable White - FineTUNE Controls Only)* [4] ◯ DMX - EldoLED POWERdrive, 0.1% ◯ DMX-TW - EldoLED POWERdrive, 0.1% *(Tunable White)* **Lutron Driver Options** ◯ LUT-ES1 - Lutron, Ecosystem 1% ◯ LUT-2W - Lutron, 2-wire (120v only) 1% ◯ LUT-TW - Lutron T-Series, EcoSystem 1% *(Tunable White)* See Page 3 for additional driver options and details

OTHER OPTIONS

Mounting Method	Ceiling Hardware Type	Endcap Style	Luminaire Finish
◯ FA50 - Fully Adjustable 50" ◯ FA100 - Fully Adjustable 100" ◯ FA150 - Fully Adjustable 150" ◯ FA200 - Fully Adjustable 200" ◯ FA250 - Fully Adjustable 250" ◯ FA300 - Fully Adjustable 300" ◯ FM - Flexible Mounting [5]	◯ C1 - 1" T-Bar ◯ C2 - 9/16" T-Bar ◯ C3 - Screw Slot ◯ C4 - Hard Ceiling	◯ FE - Flat Endcap (standard) ◯ DE - 1" Drop Down Lens [6]	◯ SW - Signal White ◯ FB - Finelite Black [7] ◯ SA - Satin Aluminum [7] ◯ #### - RAL Color Code [7] _____

OTHER OPTIONS

Emergency Style (Optional)	Integrated Sensor (Optional)	Special Options (Optional)
◯ FAC CHO - Factory Choice Battery Back-up ◯ EM/GEN - Emergency to Generator ◯ NL - Night Light ◯ BSL310LP - Bodine Battery Back up Low Profile ◯ GTD - Generator Transfer Device ◯ ALCR - Automatic Load Control Relay	◯ OBO - Occupancy ◯ OBD - Daylight ◯ OBE - Enlighted [8]	◯ CP - Chicago Plenum [9]

AS INDICATED ON PLAN

ACOUSTIC

Acoustic	Height	Acoustic Housing Color
◉ ABL - Acoustic Baffle Lit	◯ 8H ◯ 12H	◯ PEW - Pewter (standard) ◯ SLA - Slate (standard) ◯ #### - RAL Color Code [10] _____ See Page 3 for extended housing color options. Consult factory.

TBD by architect

[1] Pendant Regressed only
[2] Not available with Pendant Regressed
[3] Add DTO to gain "Dim to Off" functionality (FC-10% - DTO)
[4] B & V outputs only
[5] Not available with ID
[6] Drop Down Lens (DL) downlight only
[7] 20 Business day lead time for color
[8] Enlighted components installed by Finelite, provided by others
[9] Only available with C1, C2, and C3 mounting hardware with Finelite Gridbox
[10] Consult factory for extended acoustic housing color options

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L6A

Acoustic
HP-2 Acoustic Baffle Lit

SUPPLEMENTARY DRIVER PAGE

0-10V Driver Options	
FC-10%	Factory Choice, 0-10V 10% Dimming (Linear)
FC-10%-DTO	Factory Choice, 0-10V 10% Dimming, Dim-to-Off (Linear)
FC-1%	Factory Choice, 0-10V 1% Dimming (Linear)
FC-1%-DTO	Factory Choice, 0-10V 1% Dimming, Dim-to-Off (Linear)
ELD-10V-0%	EldoLED SOLOdrive, 0-10V 0.1% Dimming (Linear)
ELD-10V-1%	EldoLED ECOdrive, 0-10V 1% Dimming (Linear)
OSR-10V-TW	Osram OTi, 0-10V 10% Dimming, *Tunable White* (Linear)
OSR-10V-TWDTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off, *Tunable White* (Linear)
OSR-10%	Osram OTi, 0-10V 10% Dimming (Linear)
OSR-10%-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off (Linear)
OSR-1%	Osram OTi, 0-10V 1% Dimming (Linear)
OSR-1%-DTO	Osram OTi, 0-10V 1% Dimming, Dim-to-Off (Linear)

DALI Driver Options	
FC-DALI-1%	Factory Choice, DALI 1% Dimming (Logarithmic)
OSR-DALI-1%	Osram Dexal, DALI 1% Dimming (Logarithmic)
ELD-DALI-0%	EldoLED SOLOdrive, DALI 0.1% Dimming (Logarithmic)
ELD-DALI-1%	EldoLED ECOdrive, DALI 1% Dimming (Logarithmic)
ELD-DALI-TW	EldoLED DUALdrive Light Shape, DALI 1% Dimming, *Tunable White* (Logarithmic Dimming, Linear CCT Control)

DMX Driver Options	
FIN-DMX	Finelite, DMX 1% Dimming, *Tunable White* - **FineTUNE Controls Only** (Linear)
ELD-DMX	EldoLED POWERdrive, DMX 0.1% Dimming (8 Bit, 1CH) (Linear)
ELD-DMX-16	EldoLED POWERdrive, DMX 0.1% Dimming (16 Bit, 2CH) (Linear)
ELD-DMX-TW	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (8 Bit, 2CH - CH1 Warm / CH2 Cool) (Linear)
ELD-DMX-TW16	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (16 Bit, 4CH - CH1, 2 Warm / CH3, 4 Cool) (Linear)

Lutron Driver Options	
LUT-ES1	Lutron, Ecosystem 1% Dimming
LUT-2W	Lutron, 2-wire (120v only) 1% Dimming
LUT-TW	Lutron T-Series, EcoSystem 1% Dimming, *Tunable White*

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting
L6A

Acoustic
HP-2 Acoustic Baffle Lit

SPECIFICATIONS

BODY TYPE

CONSTRUCTION: Lighting luminaire body is precision-cut 6061-T6 extruded aluminum. Internal joiner system, plug-together wiring are standard. Acoustic housing is 100% Polyester fiber, joined with double-coated tape and adhesive.

LENGTHS: Standard section lengths of 4' and 8'. Combined runs available in multiples of 4' and 8'. For Indirect/Direct, select a minimum body length of 4' or greater when requiring dual circuiting or when uplight and downlight outputs differs. Acoustic housing walls are 1/2" thick and add 1" to total length.

OUTPUT AND LED TYPE

LIGHT OUTPUT: Four lumen packages available, Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). A separate chart summarizes lumen distribution and wattage. For Tailored Outputs outside of range from Standard (**S**) to Very High (**V**), consult factory. Light engines are replaceable.

MECHANICAL/OPTICAL OPTIONS

UPLIGHT OPTION: Flush frost white snap-in diffuser, 73% transmissive, 99% diffusion; Widespread Optic (**WSO**) enables increased luminaire spacing with improved ceiling uniformity. Asymmetric optic directs light in a specific direction. ASY-L distributes light to the left, ASY-R distributes light to the right of the luminaire. Consult factory for more tailored lumen outputs.

DOWNLIGHT OPTION: 8' maximum diffuser length. Flush (**F**) frost white snap-in diffuser, standard; 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination. Available with Flush (**F**), Bottom Glow (**BG**), 1" Drop Down Lens (**DL**), White Cross Blade Baffle (**WCB**) [1], Hollowed Ellipse Louver (**LHE**) [1], Hex Louver (**LHC**) [1], Downlight Spread Optic (**DSO**) and Regressed downlight diffusers (**RG**) [1]. 1" Drop Down Lens made of highly efficient acrylic. Available with a solid endcap or an endcap with a diffuse filler to continue the luminous aesthetic. Downlight Spread Optic is an extruded lens with a subtle ribbed appearance providing a batwing distribution for improved optical performance.

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

REFLECTORS: Die-formed 20-gauge cold-rolled steel reflectors finished in 96LG High Reflectance white powder coat paint.

ELECTRICAL OPTIONS

STATIC WHITE FEED: 18-gauge/5-conductor single-circuit feed, standard. 14-gauge feed used when luminaire current exceeds 5 amps.

TUNABLE WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when luminaire current exceeds 5 amps. DMX and power feed at same location (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths.

STATIC WHITE DRIVER: Replaceable 120V, 277V, and 347V constant current reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 100% - 10%. Dimming to 1% available; Consult factory. Driver is fully accessible from below the ceiling.
- **Power Factor:** ≥ 0.9
- **Total Harmonic Distortion (THD):** <20%
- **Expected driver lifetime:** 100,000 hours

LUTRON STATIC DRIVER OPTIONS:
- **LUTES1 (LDE1)** (Hi-lume 1% EcoSystem with Soft-On, Fade-to-Black dimming (LDE1 series))
- **LUT2W (LTEA2w)** (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)).

TUNABLE WHITE DRIVER: Replaceable LED driver. Driver is accessible from below the ceiling. 120V, 277V, and 347V.
- **Power factor** ≥0.9
- **Total Harmonic Distortion (THD):** <20%
- **Dimming Range:** 100% - 10%
- **Expected driver lifetime:** 100,000 hours
- FineTune DMX is 1%

LUTRON TUNABLE WHITE DRIVER OPTION: LUT-TW (1% T-Series 2-Channel Digital Tunable White (PSQ Series)).

MOUNTING OPTIONS

HANGING HARDWARE: 50" Fully Adjustable (**FA**) plated steel aircraft cable with safety stop hardware standard. Contact factory for additional lengths up to 300". The Flexible Mounting Bracket (**FM**) adjusts the suspension points to accommodate existing architecture. Suspension points adjust up to 2' in from the end of 8' luminaire and up to 1' in on a 4' luminaire.

TUNABLE WHITE DMX HANGING HARDWARE: For grid ceiling applications the dual GridBox™ mounting is supplied (standard). For hard ceiling applications the ceiling mounting box is supplied (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths. Available DMX pendant feed lengths are 5' (standard), 12', and 30'.

[1] Pendant Regressed Direct only

Continued

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Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting
L6A

Acoustic
HP-2 Acoustic Baffle Lit

SPECIFICATIONS

TUNABLE WHITE DMX INTERCONNECTION CABLES: Luminaires are pre-wired with plug-and-play interconnection cables to support easy plug-together joining of luminaire runs. If a non-FineTune DMX system is specified, a DMX to RJ45 adapter is provided.

OTHER OPTIONS

ENDCAPS: Flat diecast aluminum endcaps add 1/4" to each end of luminaire. 1" Drop Down Lens Endcap (**DE**) includes diffuse element to continue luminance of drop lens.

EMERGENCY STYLE: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, step-dimming driver, backup battery.

Backup Battery		
	Factory Choice	Bodine BSL310LP
HP2-P-D		
Min. Housing Length	8'*	4'
EM Lumen Output	1608	956
EM Section Illuminated	2'	2' or 4'
HP2-P-ID		
Min. Housing Length	12'	8'
EM Lumen Output	1854	956
EM Section Illuminated	2'	2' or 4'

* Minimum fixture housing length for battery pack approved without sensor

TUNABLE WHITE ELECTRICAL OPTIONS [2]:
- **TW Driver Options 0-10V:** EM/GEN, GTD, or Battery Back-up
- **FineTune DMX:** EM/GEN or Battery Back-up
- **DMX:** Battery Back-up
- **DALI:** EM/GEN, GTD, or Battery Back-up
- **LUTRON:** EM/GEN, GTD, or Battery Back-up

INTEGRATED SENSORS: Integrated PIR (Passive Infrared) occupancy or daylight sensors available with Flush and Bottom Glow downlight diffusers. Refer to Occupancy Sensor and Daylight Sensor tech sheets for more info.

FINISHES: Finelite Signal White (**SW**) powder coat, standard. Finelite Black (RAL 9005) with semi gloss fine texture (**FB**) [3], Satin Aluminum (**SA**) [3], and 185 RAL colors [3] are available.

LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.130 (G), this luminaire contains an internal driver disconnect. UL 924 and UL 2108 - PoE options available on request, contact factory for more details. These luminaires are rated for Damp Location. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2015/863. Consult factory for tailored lighting options.

ACOUSTIC

NRC: Noise Reduction Coefficient (NRC) is measured at six frequencies: 125Hz, 250Hz, 500Hz, 1,000Hz, 2,000Hz, and 4,000 Hz expressed to the nearest integral multiple of 0.05. Apparent NRC up to 1.20.

HEIGHTS: Housing Heights of 8" and 12" available. All heights are compatible with both Direct and Direct Regressed Luminaire Type.

COLORS: Pewter (**PEW**) and Slate (**SLA**), standard. 18 Extended color options available [4].

WEIGHT [5]:
Indirect Direct
- **8"H** 3.86 lbs/ft.
- **12"H** 4.31 lbs/ft.

Direct
- **8"H** 2.975 lbs/ft.
- **12"H** 3.35 lbs/ft.

WARRANTY: 10-year performance-based warranty on all standard direct components and indirect/direct components up to High Output (**H**). 5-year performance-based warranty for indirect/direct Very High Output (**V**). Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

[2] Consult Finelite for Generator Transfer Device and Battery Back-up fit
[3] 20 Business day lead time for color
[4] Consult factory for extended acoustic housing color options
[5] Excludes Battery Back-up and Generator Transfer Device weight

Submitted by:		Date:
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Acoustic
HP-2 Acoustic Baffle Lit

COLOR OPTIONS

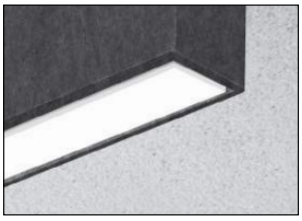
Standard **Extended** Consult factory for extended acoustic housing color options

Pewter (**PEW**) Sky (**SKY**) Cobalt (**COB**) Bark (**BAR**) Tar (**TAR**) Fossil (**FOS**) Greige (**GRE**) Cadet (**CAD**) Malachite (**MAL**) Ocher (**OCH**)

Slate (**SLA**) Mandarine (**MAN**) Grass (**GRA**) Sunshine (**SUN**) Ecru (**ECR**) Linen (**LIN**) Chambray (**CHA**) Ivory (**IVO**) Frost (**FRO**) Smoke (**SMO**)

AESTHETIC OPTIONS

Flush Diffuser (**F**)

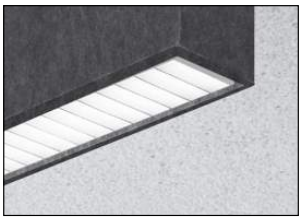


Bottom Glow Diffuser (**BG**)

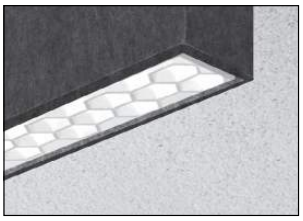
1" Drop Down Lens (**DL**)

Flat Diffuser with 1" Regressed (**RG-D**)

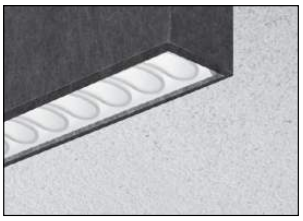
Downlight Spread Optic (**DSO**) [1]
Externally flush



White Cross Blade Baffle [2] (**RG-WCB**)



Hex Louver [2] (**RG-LHC**)



Hollowed Ellipse Louver [2] (**RG-LHE**)

[1] With a subtle ribbed appearance providing a batwing distribution
[2] Regressed only.

STANDARD RUN CONFIGURATIONS

Run Length (ft)	Configuration	Hanging Points
12	8 + 4	3
16	8 + 8	3
20	8 + 8 + 4	4
24	8 + 8 + 8	4
28	8 + 8 + 8 + 4	5
32	8 + 8 + 8 + 8	5
36	8 + 8 + 8 + 8 + 4	6
40	8 + 8 + 8 + 8 + 8	6
44	8 + 8 + 8 + 8 + 8 + 4	7
48	8 + 8 + 8 + 8 + 8 + 8	7
52	8 + 8 + 8 + 8 + 8 + 8 + 4	8
56	8 + 8 + 8 + 8 + 8 + 8 + 8	8
60	8 + 8 + 8 + 8 + 8 + 8 + 8 + 4	9

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

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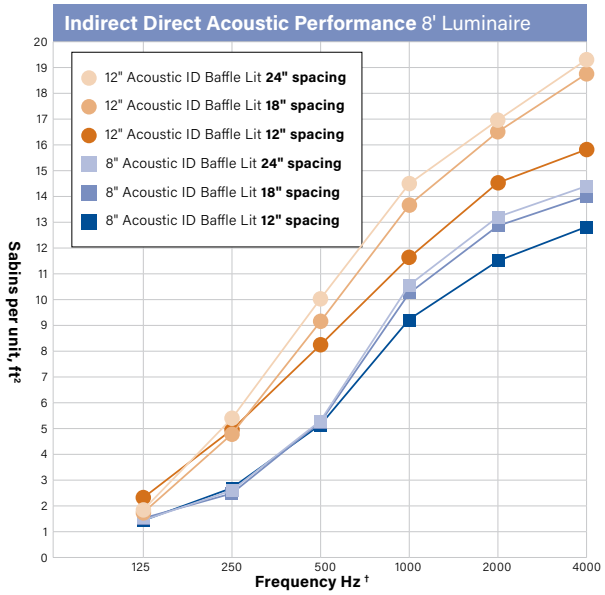
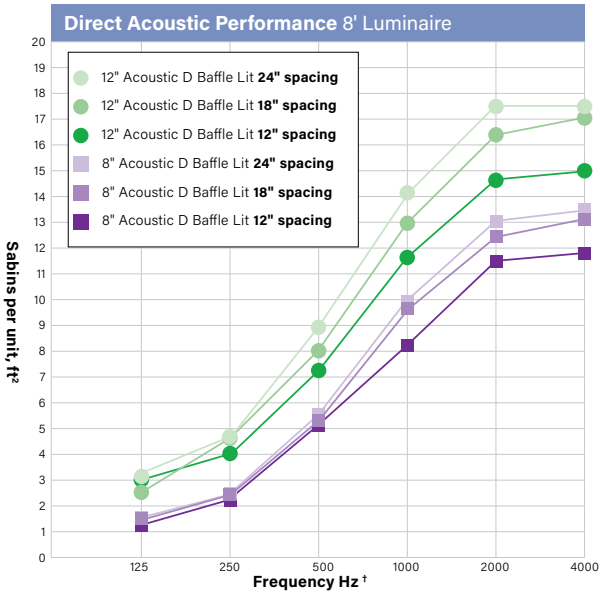
L6A

Acoustic
HP-2 Acoustic Baffle Lit

Acoustic Performance Graph Sabins by Frequency





Acoustic Product Properties Per-Unit Sabins, Apparent NRC & SAA

Product	Spacing	Sabins (ft² of sound absorption area) per Unit						Equivalent ceiling treatment ‡	
		125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	Apparent NRC	Apparent SAA
HP-2 Acoustic ID Baffle Lit 12"	Spaced 24"	1.90	5.30	10.05	14.52	17.29	19.39	0.75	0.72
	Spaced 18"	1.69	4.84	9.02	13.62	16.54	18.71	0.90	0.91
	Spaced 12"	2.28	4.95	8.22	11.64	14.52	15.73	1.20	1.21
HP-2 Acoustic ID Baffle Lit 8"	Spaced 24"	1.44	2.68	5.36	10.53	13.10	14.36	0.50	0.49
	Spaced 18"	1.62	2.62	4.93	10.21	12.76	14.03	0.65	0.63
	Spaced 12"	1.54	2.66	5.22	9.27	11.59	12.85	0.90	0.87
HP-2 Acoustic D Baffle Lit 12"	Spaced 24"	3.13	4.77	8.91	14.16	17.41	17.41	0.70	0.69
	Spaced 18"	2.54	4.65	8.04	13.09	16.37	17.07	0.85	0.87
	Spaced 12"	3.06	4.07	7.25	11.67	14.67	15.00	1.15	1.16
HP-2 Acoustic D Baffle Lit 8"	Spaced 24"	1.50	2.49	5.57	9.91	13.07	13.55	0.50	0.48
	Spaced 18"	1.47	2.38	5.35	9.68	12.40	13.15	0.60	0.61
	Spaced 12"	1.33	2.24	5.23	8.29	11.46	11.85	0.85	0.84

† 1/3 octave band test results presented and 1/1 octave band center frequencies

‡ Apparent NRC & SAA ratings were calculated from the measured total absorption in Sabins divided by the area of a projected horizontal plane that encompasses the set of objects. This provides an accurate comparison to 2-dimensional ceiling surface treatment options.

NOTE: Acoustic Performance Testing conducted by Riverbank Acoustical Laboratories.
Reference reports RAL-A19-505, RAL-A21-079, RAL-A21-080, RAL-A21-081, RAL-A21-086, RAL-A21-087, RAL-A21-088

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

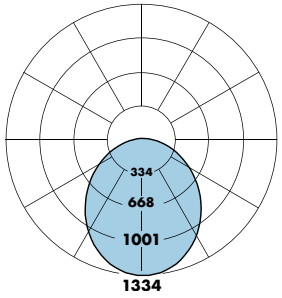
FINELITE® Better Lighting

L6A

Acoustic
HP-2 Acoustic Baffle Lit
Direct Photometry 4' Luminaire 3500K

HP2-P-D-V-835-F
Downlight: Flush Diffuser

Efficacy: 87 lm/W
Total luminaire output: 3215 lumens (804 lm/ft)
36.9 watts (9.2 W/ft)
Peak Candela Value: 1334 @ 0°
CRI: 80 / CCT: 3500K
ITL LM79 Report 85136



CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0	Flux
0	1334	1334	1334	1334	1334	
5	1327	1326	1326	1325	1324	126
15	1263	1252	1251	1244	1236	352
25	1133	1117	1109	1088	1075	508
35	958	942	923	896	887	576
45	762	747	725	697	686	558
55	563	551	532	509	500	475
65	374	365	351	337	331	349
75	206	201	195	188	184	207
85	62	61	59	57	57	66
90	0	0	0	0	0	

Complete LM79 LED Photometry

Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire			
S [1]	**B** [1]	**H** [1]	**V** [2]
1316	1655	2501	3215

Light Output, 3500K, 80 CRI (Lumens Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
329	414	625	804

Power, 3500K (Watts Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
3.6	4.6	7.1	9.2

Efficacy, 3500K, 80 CRI (Lumens Per Watt)			
S [1]	**B** [1]	**H** [1]	**V** [2]
91	90	88	87

Sample Lumen Adjustment Calculation

Lumen Adjustment Factors 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

Lumen Adjustment Factors 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

High Output (**H**), 4000K, 90 CRI

Lumen Adjustment Factor: 0.789

Total Light Output: 2501 lm x 0.789 = 1973 lm

Total Light Output per Foot: 625 lm/ft x 0.789 = 493 lm/ft.

watts/foot: 7.1 W/ft.

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output
[1] Based on 4' luminaire 3500K Very High Output (**V**) test - 120V.
[2] Based on ITL report: 85136

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L6B

Acoustic
HP-2 Acoustic Baffle Lit

HP-2 Acoustic Baffle Lit is a high-performing, sound-absorbing LED pendant luminaire with a 2" aperture. It's available in direct and indirect/direct, flush or regressed options. This luminaire offers a sophisticated and convenient way to achieve desired illumination and reverberation levels in open space environments. HP-2 Acoustic contributes towards WELL Sound Absorption SO4 requirements.

Pewter housing shown
Pewter or Slate are standard housing color options; Signal White luminaire finish is standard.

Great Sound Absorption

1.20 NRC — Apparent noise reduction coefficient (NRC) up to 1.20.

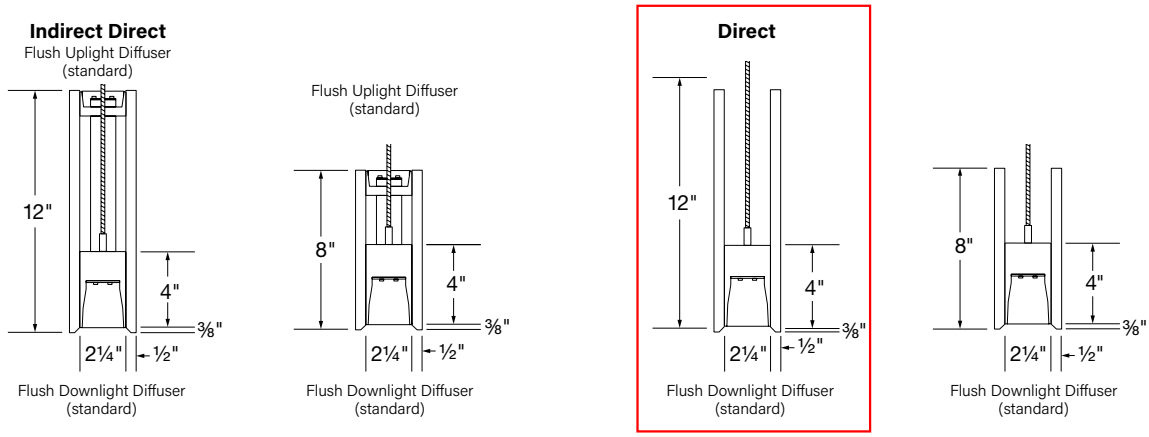
10 Day Shipping

10 Working day — 10-Working day shipping on standard orders. Consult factory for extended acoustic housing color options.

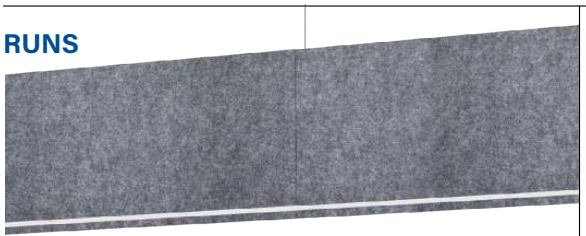
Quality Material

A ASTM — Class A fire resistant material (ASTM E-84); Moisture resistant.

CROSS SECTIONS **Standard body shown. D, I/D, 8", and 12" options also available with regressed body.**



RUNS



Now available in continuous runs and independent section lengths. See page 6 for configurations

COMPLEMENTARY PRODUCT

HP-2 Acoustic Baffle Unlit
Pair with this sound-absorbing and eco-friendly unlit pendant baffle to achieve desired reverberation levels with a consistent aesthetic.

Refer to complementary tech sheet

Industry Best 10 Year LED Warranty
Fine TUNE Generation 7 Option Available
WELL v2

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L6B

Acoustic
HP-2 Acoustic Baffle Lit

BODY TYPE

Platform	Series Name	Luminaire Type	Luminaire Distribution	Total Run
◉ HP - High Performance	◉ 2	◯ P - Pendant ◯ P RG - Pendant Regressed	◯ D - Direct ◯ ID - Indirect Direct	10ft Multiples of 4' and 8' sections, standard

OUTPUT and LED TYPE

Uplight Output ID only	Downlight Output
◯ S - Standard ◯ B - Boosted Standard ◯ H - High ◯ V - Very High ◯ TL - Tailored: _____lm/ft *	◯ S - Standard (329 lm/ft) ◯ B - Boosted Standard (414 lm/ft) ◯ H - High (625 lm/ft) ◯ V - Very High (804 lm/ft) ◯ TL - Tailored: _____lm/ft *

* Specify lm/ft of outputs between Standard (S) and Very High (V). Consult factory for tailored lumen output outside of this range.

OUTPUT and LED TYPE

LED CRI/CCT
◯ 830 - 80 CRI min, 3000K
◯ 835 - 80 CRI min, 3500K
◯ 840 - 80 CRI min, 4000K
◯ 930 - 90 CRI min, 3000K
◯ 935 - 90 CRI min, 3500K
◯ 940 - 90 CRI min, 4000K
◯ 8TW - 80 CRI min, Tunable White
◯ 9TW - 90 CRI min, Tunable White

MECHANICAL/OPTICAL OPTIONS

Uplight Option ID only	Downlight Option	Reflector System
◯ F - Flush (standard) ◯ WSO - Widespread Optic ◯ ASY-L - Asymmetric Left ◯ ASY-R - Asymmetric Right	◯ F - Flush (standard) ◯ BG - Bottom Glow ◯ DL - 1" Drop Down Lens ◯ RG-D - Flat Diffuser with 1" Regress [1] ◯ RG-WCB - White Cross Blade Baffle [1] ◯ RG-LHE - Hollowed Ellipse Louver [1] ◯ RG-LHC - Hex Louver [1] ◯ DSO - Downlight Spread Optic [2]	◉ 96 - 96 Low Gloss White

ELECTRICAL OPTIONS

Voltage	Circuiting	Driver Selection
◯ 120 - 120 Voltage ◯ 277 - 277 Voltage ◯ 347 - 347 Voltage	◯ SC - Single Circuit* One single circuit in a run ◯ DC - Dual Circuit* Independent control of up and down separately in an I/D style fixture ◯ MC - Multi Circuit* More than one switch leg or zone (not 'DC' independent control of up and down separately for an I/D style fixture) Factory shop drawings required Battery, Night Light, and Emergency to Generator circuits are in addition to the normal luminaire circuit(s)	**0-10V Driver Options** ◯ FC-10% - 0-10V 10% (standard) [3] ◯ FC-1% - 0-10V 1% [3] ◯ OSR-10% - Osram OTi, 0-10V 10% [3] ◯ OSR-1% - Osram OTi, 0-10V 1% [3] ◯ ELD-10V - EldoLED SOLOdrive, 0-10V 0.1% ◯ 10V-TW - Osram OTi, 0-10V 10% *(Tunable White)* [3] **DALI Driver Options** ◯ FC-DALI - DALI 1% ◯ OSR-DALI - Osram Dexal, 1% ◯ ELD-DALI - EldoLED SOLOdrive, DALI 0.1% ◯ DALI-TW - EldoLED Dual Drive Light Shape, 1% *(Tunable White)* **DMX Driver Options** ◯ FIN-DMX - Finelite DMX 1% *(Tunable White - FineTUNE Controls Only)* [4] ◯ DMX - EldoLED POWERdrive, 0.1% ◯ DMX-TW - EldoLED POWERdrive, 0.1% *(Tunable White)* **Lutron Driver Options** ◯ LUT-ES1 - Lutron, Ecosystem 1% ◯ LUT-2W - Lutron, 2-wire (120v only) 1% ◯ LUT-TW - Lutron T-Series, EcoSystem 1% *(Tunable White)* See Page 3 for additional driver options and details

OTHER OPTIONS

Mounting Method	Ceiling Hardware Type	Endcap Style	Luminaire Finish
◯ FA50 - Fully Adjustable 50" ◯ FA100 - Fully Adjustable 100" ◯ FA150 - Fully Adjustable 150" ◯ FA200 - Fully Adjustable 200" ◯ FA250 - Fully Adjustable 250" ◯ FA300 - Fully Adjustable 300" ◯ FM - Flexible Mounting [5]	◯ C1 - 1" T-Bar ◯ C2 - 9/16" T-Bar ◯ C3 - Screw Slot ◯ C4 - Hard Ceiling	◯ FE - Flat Endcap (standard) ◯ DE - 1" Drop Down Lens [6]	◯ SW - Signal White ◯ FB - Finelite Black [7] ◯ SA - Satin Aluminum [7] ◯ #### - RAL Color Code [7] _____

OTHER OPTIONS

Emergency Style (Optional)	Integrated Sensor (Optional)	Special Options (Optional)
◯ FAC CHO - Factory Choice Battery Back-up ◯ EM/GEN - Emergency to Generator ◯ NL - Night Light ◯ BSL310LP - Bodine Battery Back up Low Profile ◯ GTD - Generator Transfer Device ◯ ALCR - Automatic Load Control Relay	◯ OBO - Occupancy ◯ OBD - Daylight ◯ OBE - Enlighted [8]	◯ CP - Chicago Plenum [9]

ACOUSTIC

Acoustic	Height	Acoustic Housing Color
◉ ABL - Acoustic Baffle Lit	◯ 8H ◯ 12H	◯ PEW - Pewter (standard) ◯ SLA - Slate (standard) ◯ #### - RAL Color Code [10] _____ See Page 3 for extended housing color options. Consult factory.

TBD by architect

[1] Pendant Regressed only
[2] Not available with Pendant Regressed
[3] Add DTO to gain "Dim to Off" functionality (FC-10% - DTO)
[4] B & V outputs only
[5] Not available with ID
[6] 1" Drop Down Lens (DL) downlight only
[7] 20 Business day lead time for color
[8] Enlighted components installed by Finelite, provided by others
[9] Only available with C1, C2, and C3 mounting hardware with Finelite Gridbox
[10] Consult factory for extended acoustic housing color options

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L6B

Acoustic
HP-2 Acoustic Baffle Lit

SUPPLEMENTARY DRIVER PAGE

0-10V Driver Options	
FC-10%	Factory Choice, 0-10V 10% Dimming (Linear)
FC-10%-DTO	Factory Choice, 0-10V 10% Dimming, Dim-to-Off (Linear)
FC-1%	Factory Choice, 0-10V 1% Dimming (Linear)
FC-1%-DTO	Factory Choice, 0-10V 1% Dimming, Dim-to-Off (Linear)
ELD-10V-0%	EldoLED SOLOdrive, 0-10V 0.1% Dimming (Linear)
ELD-10V-1%	EldoLED ECOdrive, 0-10V 1% Dimming (Linear)
OSR-10V-TW	Osram OTi, 0-10V 10% Dimming, *Tunable White* (Linear)
OSR-10V-TWDTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off, *Tunable White* (Linear)
OSR-10%	Osram OTi, 0-10V 10% Dimming (Linear)
OSR-10%-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off (Linear)
OSR-1%	Osram OTi, 0-10V 1% Dimming (Linear)
OSR-1%-DTO	Osram OTi, 0-10V 1% Dimming, Dim-to-Off (Linear)

DALI Driver Options	
FC-DALI-1%	Factory Choice, DALI 1% Dimming (Logarithmic)
OSR-DALI-1%	Osram Dexal, DALI 1% Dimming (Logarithmic)
ELD-DALI-0%	EldoLED SOLOdrive, DALI 0.1% Dimming (Logarithmic)
ELD-DALI-1%	EldoLED ECOdrive, DALI 1% Dimming (Logarithmic)
ELD-DALI-TW	EldoLED DUALdrive Light Shape, DALI 1% Dimming, *Tunable White* (Logarithmic Dimming, Linear CCT Control)

DMX Driver Options	
FIN-DMX	Finelite, DMX 1% Dimming, *Tunable White* - **FineTUNE Controls Only** (Linear)
ELD-DMX	EldoLED POWERdrive, DMX 0.1% Dimming (8 Bit, 1CH) (Linear)
ELD-DMX-16	EldoLED POWERdrive, DMX 0.1% Dimming (16 Bit, 2CH) (Linear)
ELD-DMX-TW	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (8 Bit, 2CH - CH1 Warm / CH2 Cool) (Linear)
ELD-DMX-TW16	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (16 Bit, 4CH - CH1, 2 Warm / CH3, 4 Cool) (Linear)

Lutron Driver Options	
LUT-ES1	Lutron, Ecosystem 1% Dimming
LUT-2W	Lutron, 2-wire (120v only) 1% Dimming
LUT-TW	Lutron T-Series, EcoSystem 1% Dimming, *Tunable White*

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L6B

Acoustic
HP-2 Acoustic Baffle Lit

SPECIFICATIONS

BODY TYPE

CONSTRUCTION: Lighting luminaire body is precision-cut 6061-T6 extruded aluminum. Internal joiner system, plug-together wiring are standard. Acoustic housing is 100% Polyester fiber, joined with double-coated tape and adhesive.

LENGTHS: Standard section lengths of 4' and 8'. Combined runs available in multiples of 4' and 8'. For Indirect/Direct, select a minimum body length of 4' or greater when requiring dual circuiting or when uplight and downlight outputs differs. Acoustic housing walls are 1/2" thick and add 1" to total length.

OUTPUT AND LED TYPE

LIGHT OUTPUT: Four lumen packages available, Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). A separate chart summarizes lumen distribution and wattage. For Tailored Outputs outside of range from Standard (**S**) to Very High (**V**), consult factory. Light engines are replaceable.

MECHANICAL/OPTICAL OPTIONS

UPLIGHT OPTION: Flush frost white snap-in diffuser, 73% transmissive, 99% diffusion; Widespread Optic (**WSO**) enables increased luminaire spacing with improved ceiling uniformity. Asymmetric optic directs light in a specific direction. ASY-L distributes light to the left, ASY-R distributes light to the right of the luminaire. Consult factory for more tailored lumen outputs.

DOWNLIGHT OPTION: 8' maximum diffuser length. Flush (**F**) frost white snap-in diffuser, standard; 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination. Available with Flush (**F**), Bottom Glow (**BG**), 1" Drop Down Lens (**DL**), White Cross Blade Baffle (**WCB**) [1], Hollowed Ellipse Louver (**LHE**) [1], Hex Louver (**LHC**) [1], Downlight Spread Optic (**DSO**) and Regressed downlight diffusers (**RG**) [1]. 1" Drop Down Lens made of highly efficient acrylic. Available with a solid endcap or an endcap with a diffuse filler to continue the luminous aesthetic. Downlight Spread Optic is an extruded lens with a subtle ribbed appearance providing a batwing distribution for improved optical performance.

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

REFLECTORS: Die-formed 20-gauge cold-rolled steel reflectors finished in 96LG High Reflectance white powder coat paint.

ELECTRICAL OPTIONS

STATIC WHITE FEED: 18-gauge/5-conductor single-circuit feed, standard. 14-gauge feed used when luminaire current exceeds 5 amps.

TUNABLE WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when luminaire current exceeds 5 amps. DMX and power feed at same location (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths.

STATIC WHITE DRIVER: Replaceable 120V, 277V, and 347V constant current reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 100% - 10%. Dimming to 1% available; Consult factory. Driver is fully accessible from below the ceiling.
- **Power Factor:** ≥ 0.9
- **Total Harmonic Distortion (THD):** <20%
- **Expected driver lifetime:** 100,000 hours

LUTRON STATIC DRIVER OPTIONS:
- **LUTES1 (LDE1)** (Hi-lume 1% EcoSystem with Soft-On, Fade-to-Black dimming (LDE1 series))
- **LUT2W (LTEA2w)** (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)).

TUNABLE WHITE DRIVER: Replaceable LED driver. Driver is accessible from below the ceiling. 120V, 277V, and 347V.
- **Power factor** ≥0.9
- **Total Harmonic Distortion (THD):** <20%
- **Dimming Range:** 100% - 10%
- **Expected driver lifetime:** 100,000 hours
- FineTune DMX is 1%

LUTRON TUNABLE WHITE DRIVER OPTION: LUT-TW (1% T-Series 2-Channel Digital Tunable White (PSQ Series)).

MOUNTING OPTIONS

HANGING HARDWARE: 50" Fully Adjustable (**FA**) plated steel aircraft cable with safety stop hardware standard. Contact factory for additional lengths up to 300". The Flexible Mounting Bracket (**FM**) adjusts the suspension points to accommodate existing architecture. Suspension points adjust up to 2' in from the end of 8' luminaire and up to 1' in on a 4' luminaire.

TUNABLE WHITE DMX HANGING HARDWARE: For grid ceiling applications the dual GridBox™ mounting is supplied (standard). For hard ceiling applications the ceiling mounting box is supplied (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths. Available DMX pendant feed lengths are 5' (standard), 12', and 30'.

[1] Pendant Regressed Direct only

Continued

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Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting
L6B

Acoustic
HP-2 Acoustic Baffle Lit

SPECIFICATIONS

TUNABLE WHITE DMX INTERCONNECTION CABLES: Luminaires are pre-wired with plug-and-play interconnection cables to support easy plug-together joining of luminaire runs. If a non-FineTune DMX system is specified, a DMX to RJ45 adapter is provided.

OTHER OPTIONS

ENDCAPS: Flat diecast aluminum endcaps add 1/4" to each end of luminaire. 1" Drop Down Lens Endcap (**DE**) includes diffuse element to continue luminance of drop lens.

EMERGENCY STYLE: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, step-dimming driver, backup battery.

Backup Battery		
	Factory Choice	Bodine BSL310LP
HP2-P-D		
Min. Housing Length	8'*	4'
EM Lumen Output	1608	956
EM Section Illuminated	2'	2' or 4'
HP2-P-ID		
Min. Housing Length	12'	8'
EM Lumen Output	1854	956
EM Section Illuminated	2'	2' or 4'

* Minimum fixture housing length for battery pack approved without sensor

TUNABLE WHITE ELECTRICAL OPTIONS [2]:
- **TW Driver Options 0-10V:** EM/GEN, GTD, or Battery Back-up
- **FineTune DMX:** EM/GEN or Battery Back-up
- **DMX:** Battery Back-up
- **DALI:** EM/GEN, GTD, or Battery Back-up
- **LUTRON:** EM/GEN, GTD, or Battery Back-up

INTEGRATED SENSORS: Integrated PIR (Passive Infrared) occupancy or daylight sensors available with Flush and Bottom Glow downlight diffusers. Refer to Occupancy Sensor and Daylight Sensor tech sheets for more info.

FINISHES: Finelite Signal White (**SW**) powder coat, standard. Finelite Black (RAL 9005) with semi gloss fine texture (**FB**) [3], Satin Aluminum (**SA**) [3], and 185 RAL colors [3] are available.

LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.130 (G), this luminaire contains an internal driver disconnect. UL 924 and UL 2108 - PoE options available on request, contact factory for more details. These luminaires are rated for Damp Location. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2015/863. Consult factory for tailored lighting options.

ACOUSTIC

NRC: Noise Reduction Coefficient (NRC) is measured at six frequencies: 125Hz, 250Hz, 500Hz, 1,000Hz, 2,000Hz, and 4,000 Hz expressed to the nearest integral multiple of 0.05. Apparent NRC up to 1.20.

HEIGHTS: Housing Heights of 8" and 12" available. All heights are compatible with both Direct and Direct Regressed Luminaire Type.

COLORS: Pewter (**PEW**) and Slate (**SLA**), standard. 18 Extended color options available [4].

WEIGHT [5]:
Indirect Direct
- **8"H** 3.86 lbs/ft.
- **12"H** 4.31 lbs/ft.

Direct
- **8"H** 2.975 lbs/ft.
- **12"H** 3.35 lbs/ft.

WARRANTY: 10-year performance-based warranty on all standard direct components and indirect/direct components up to High Output (**H**). 5-year performance-based warranty for indirect/direct Very High Output (**V**). Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

[2] Consult Finelite for Generator Transfer Device and Battery Back-up fit
[3] 20 Business day lead time for color
[4] Consult factory for extended acoustic housing color options
[5] Excludes Battery Back-up and Generator Transfer Device weight

Submitted by:	Date:
Type:	Project:
Ordering Info:	

FINELITE®
Better Lighting

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Acoustic
HP-2 Acoustic Baffle Lit

COLOR OPTIONS

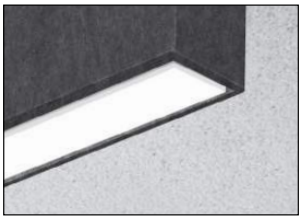
Standard **Extended** Consult factory for extended acoustic housing color options

Pewter (**PEW**) Slate (**SLA**)

Sky (**SKY**) Cobalt (**COB**) Bark (**BAR**) Tar (**TAR**) Fossil (**FOS**) Greige (**GRE**) Cadet (**CAD**) Malachite (**MAL**) Ocher (**OCH**)
Mandarine (**MAN**) Grass (**GRA**) Sunshine (**SUN**) Ecru (**ECR**) Linen (**LIN**) Chambray (**CHA**) Ivory (**IVO**) Frost (**FRO**) Smoke (**SMO**)

AESTHETIC OPTIONS

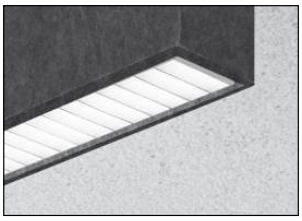

Flush Diffuser (**F**)

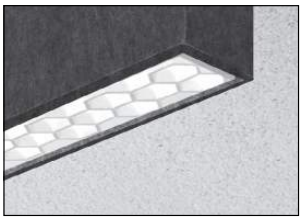

Bottom Glow Diffuser (**BG**)

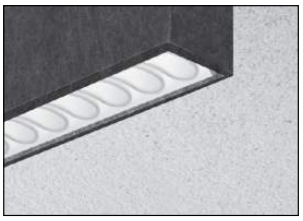

1" Drop Down Lens (**DL**)


Flat Diffuser with 1" Regressed (**RG-D**)


Downlight Spread Optic (**DSO**) [1]
Externally flush


White Cross Blade Baffle [2] (**RG-WCB**)


Hex Louver [2] (**RG-LHC**)


Hollowed Ellipse Louver [2] (**RG-LHE**)

[1] With a subtle ribbed appearance providing a batwing distribution
[2] Regressed only.

STANDARD RUN CONFIGURATIONS

Run Length (ft)	Configuration	Hanging Points
12	8 + 4	3
16	8 + 8	3
20	8 + 8 + 4	4
24	8 + 8 + 8	4
28	8 + 8 + 8 + 4	5
32	8 + 8 + 8 + 8	5
36	8 + 8 + 8 + 8 + 4	6
40	8 + 8 + 8 + 8 + 8	6
44	8 + 8 + 8 + 8 + 8 + 4	7
48	8 + 8 + 8 + 8 + 8 + 8	7
52	8 + 8 + 8 + 8 + 8 + 8 + 4	8
56	8 + 8 + 8 + 8 + 8 + 8 + 8	8
60	8 + 8 + 8 + 8 + 8 + 8 + 8 + 4	9

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

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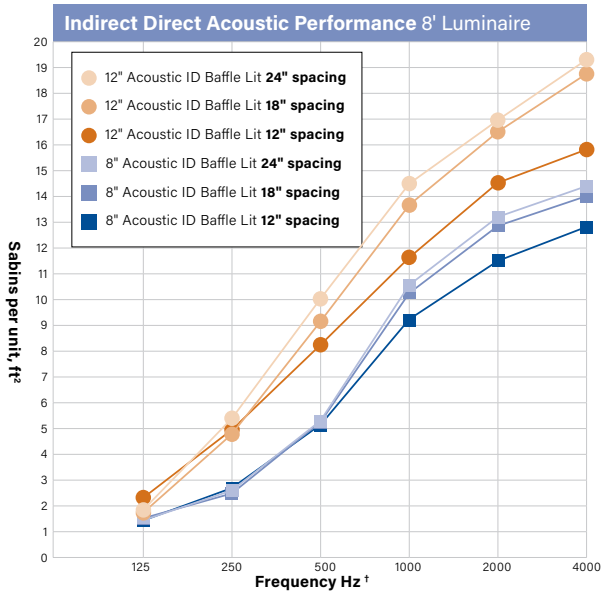
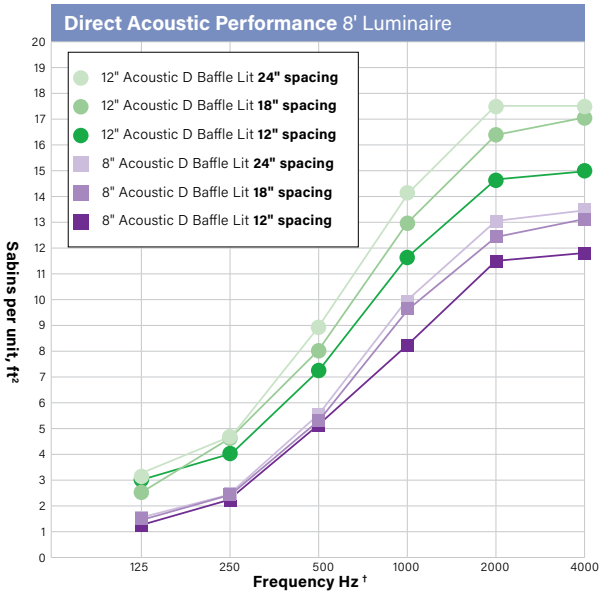
Acoustic
HP-2 Acoustic Baffle Lit

Acoustic Performance Graph Sabins by Frequency





Acoustic Product Properties Per-Unit Sabins, Apparent NRC & SAA

Product	Spacing	Sabins (ft² of sound absorption area) per Unit						Equivalent ceiling treatment ‡	
		125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	Apparent NRC	Apparent SAA
HP-2 Acoustic ID Baffle Lit 12"	Spaced 24"	1.90	5.30	10.05	14.52	17.29	19.39	0.75	0.72
	Spaced 18"	1.69	4.84	9.02	13.62	16.54	18.71	0.90	0.91
	Spaced 12"	2.28	4.95	8.22	11.64	14.52	15.73	1.20	1.21
HP-2 Acoustic ID Baffle Lit 8"	Spaced 24"	1.44	2.68	5.36	10.53	13.10	14.36	0.50	0.49
	Spaced 18"	1.62	2.62	4.93	10.21	12.76	14.03	0.65	0.63
	Spaced 12"	1.54	2.66	5.22	9.27	11.59	12.85	0.90	0.87
HP-2 Acoustic D Baffle Lit 12"	Spaced 24"	3.13	4.77	8.91	14.16	17.41	17.41	0.70	0.69
	Spaced 18"	2.54	4.65	8.04	13.09	16.37	17.07	0.85	0.87
	Spaced 12"	3.06	4.07	7.25	11.67	14.67	15.00	1.15	1.16
HP-2 Acoustic D Baffle Lit 8"	Spaced 24"	1.50	2.49	5.57	9.91	13.07	13.55	0.50	0.48
	Spaced 18"	1.47	2.38	5.35	9.68	12.40	13.15	0.60	0.61
	Spaced 12"	1.33	2.24	5.23	8.29	11.46	11.85	0.85	0.84

† 1/3 octave band test results presented and 1/1 octave band center frequencies

‡ Apparent NRC & SAA ratings were calculated from the measured total absorption in Sabins divided by the area of a projected horizontal plane that encompasses the set of objects. This provides an accurate comparison to 2-dimensional ceiling surface treatment options.

NOTE: Acoustic Performance Testing conducted by Riverbank Acoustical Laboratories.
Reference reports RAL-A19-505, RAL-A21-079, RAL-A21-080, RAL-A21-081, RAL-A21-086, RAL-A21-087, RAL-A21-088

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

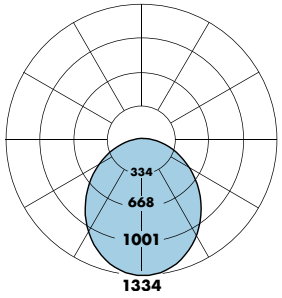
FINELITE® Better Lighting

L6B

Acoustic
HP-2 Acoustic Baffle Lit
Direct Photometry 4' Luminaire 3500K

HP2-P-D-V-835-F
Downlight: Flush Diffuser

Efficacy: 87 lm/W
Total luminaire output: 3215 lumens (804 lm/ft)
36.9 watts (9.2 W/ft)
Peak Candela Value: 1334 @ 0°
CRI: 80 / CCT: 3500K
ITL LM79 Report 85136



CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0	Flux
0	1334	1334	1334	1334	1334	
5	1327	1326	1326	1325	1324	126
15	1263	1252	1251	1244	1236	352
25	1133	1117	1109	1088	1075	508
35	958	942	923	896	887	576
45	762	747	725	697	686	558
55	563	551	532	509	500	475
65	374	365	351	337	331	349
75	206	201	195	188	184	207
85	62	61	59	57	57	66
90	0	0	0	0	0	

Complete LM79 LED Photometry

Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire			
S [1]	**B** [1]	**H** [1]	**V** [2]
1316	1655	2501	3215

Light Output, 3500K, 80 CRI (Lumens Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
329	414	625	804

Power, 3500K (Watts Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
3.6	4.6	7.1	9.2

Efficacy, 3500K, 80 CRI (Lumens Per Watt)			
S [1]	**B** [1]	**H** [1]	**V** [2]
91	90	88	87

Sample Lumen Adjustment Calculation

Lumen Adjustment Factors 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

Lumen Adjustment Factors 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

High Output (**H**), 4000K, 90 CRI

Lumen Adjustment Factor: 0.789

Total Light Output: 2501 lm x 0.789 = 1973 lm

Total Light Output per Foot: 625 lm/ft x 0.789 = 493 lm/ft.

watts/foot: 7.1 W/ft.

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output
[1] Based on 4' luminaire 3500K Very High Output (**V**) test - 120V.
[2] Based on ITL report: 85136

gotham® | EVO®

Multiple Layers of Light

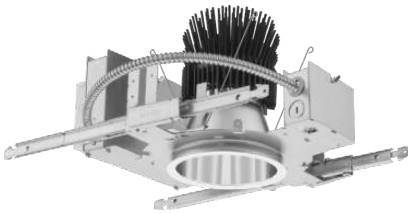
Luminaire Type: L7A

Catalog Number:

Approved Alternate Manufacturers:
Portfolio "LD6A10" Series
Indy "L6" Series
Vantage 6" Downlight

General Illumination Round Downlight 6"

250 - 8,000 lumens



10,000 - 17,500 lumens

OVERVIEW

Feature Set

- Bounding Ray™ optical design
- Unitized optics mechanically attach the light engine to the lower reflector for complete optical alignment.
- 45° cutoff to source and source image
- Fully serviceable and upgradeable lensed LED light engine
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling
- Available with 10% dimming, 1% dimming, or dim to dark
- Batwing distribution with feathered edges provides even illumination on horizontal and vertical surfaces
- ENERGY STAR® certified product

Distribution

Superior Performance

Nominal Lumens	250	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000	6000	8000	10,000	12,000	15,000	17,500
Delivered Lumens	297	519	776	994	1471	2006	2537	3077	3542	4027	4533	5256	6371	8247	10637	12332	15776	17801
Wattage	3.4	6.2	8.2	9.6	14.7	19.7	24.7	29.5	33.8	39.0	47.3	48.7	57.6	74.9	97.1	115.0	150.9	175.3
Lumens per Watt	87.4	83.7	94.6	103.5	100.1	101.8	102.7	104.3	104.8	103.3	95.8	107.9	110.6	110.1	109.5	107.2	104.5	101.5

COMPLIMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light

General Illumination Layer | EVO

High Center Beam Layer | Incito

EVO + Incito — Multiple Layers of Light

Core

Healthcare

Special Applications

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com

gotham® | EVO®

6" General Illumination Round Downlight

ORDERING INFORMATION

A+ Capable options indicated by this color background.

Design2Ship Quick Ship Program: Options in green text qualify for Design2Ship — 5 business days from order entry to ship. Refer to Design2Ship Brochure for complete program details. **Maximum Order Quantity: 100 units; 50 for Chicago Plenum.**

Luminaire Type: L7A

Catalog Number:

EXAMPLE: EV06 35/150 AR MWD LSS MVOLT EZ1

Series	Color Temperature	Nominal Lumen Values	Reflector & Flange Color	Trim Style	Distribution
EV06	27/ 2700 K 30/ 3000 K 35/ 3500 K 40/ 4000 K 50/ 5000 K	02 250 lumens 05 500 lumens 07 750 lumens 10 1000 lumens 15 1500 lumens 20 2000 lumens 25 2500 lumens 30 3000 lumens 35 3500 lumens 40 4000 lumens 45 4500 lumens 50 5000 lumens 60 6000 lumens 80 8000 lumens 100 10000 lumens 120 12000 lumens 150 15000 lumens 175 17500 lumens	AR Clear PR Pewter WTR Wheat GR Gold WR[1] White BR[1] Black WRAMF[1] White Anti-microbial	(blank) Self-flanged FL Flangeless	VND Very Narrow (0.5 s/mh) ND Narrow (0.7 s/mh) MD Medium (0.9 s/mh) MWD Medium Wide (1.0 s/mh) WD Wide (1.2 s/mh)

Finish	Voltage	Driver[4]	
LSS Semi-specular LD Matte-diffuse LS Specular	MVOLT 120 277 347[2,3]	GZ10 0-10V driver dims to 10% GZ1 0-10V driver dims to 1% EZ10 eldoLED 0-10V ECOdrive. Linear dimming to 10% min. EZ1 eldoLED 0-10V ECOdrive. Linear dimming to 1% min. EZB eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%. EDAB[5] eldoLED SOLOdrive DALI. Logarithmic dimming to <1%. EDXB[5] eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Includes termination resistor. Refer to DMXR Manual. Minimum 1000 lumens/Maximum 15000 lumens.	ECOS2[5] Lutron® Hi-Lume® 2-wire forward-phase driver. Minimum dimming level 1%, 120V only. Minimum 1000 lumens/Maximum 4000 lumens. ECOD[5] Lutron Ecosystem digital Hi-Lume 1% soft-on, fade to black. Max: 4000LM.

Control Interface	Options		
NLT[6] nLight® dimming pack controls NLTER[2,6,9] nLight® dimming pack controls emergency circuit NLTAIR2[13] nLight® AIR enabled NLTAIRER2[2,9,13] nLight® AIR enabled emergency EXA1 XPoint Wireless, eldoLED driver. Linear dimming to 1% EXAB XPoint Wireless, eldoLED driver. Logarithmic dimming to 0.1%	SF Single fuse. Specify 120V or 277V. TRW[7] White painted flange TRBL[8] Black painted flange EL Emergency battery pack, 10W, with integral test switch ELR Emergency battery pack, 10W, with self-diagnostics, with remote test switch ELSD Emergency battery pack, 10W, with self-diagnostics, integral test switch ELRSD Emergency battery pack, 10W, with self-diagnostics, remote test switch E10WCP Emergency battery pack, 10W Constant Power, CA Title 20 compliant with integral test switch E10WCPR Emergency battery pack, 10W Constant Power, CA Title 20 compliant with remote test switch	N80[10] nLight® Lumen Compensation BGTD Bodine generator transfer device. Specify 120V or 277V. 90CRI High CRI (90+) CP[11] Chicago Plenum. Specify 120V or 277V for 5000lm and above. HAO[12] HAO High Ambient Option (40°C) RRL_ RELOC®-ready luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Refer to RRL for complete nomenclature	

Provide for EM lights only

ACCESSORIES – order as separate catalog numbers (shipped separately)

SCA6	Sloped ceiling adapter. Degree of slope must be specified (5D, 10D, 15D, 20D, 25D, 30D). Ex: SCA6 10D. Refer to TECH-190.
CTA4-8 YKHL	Ceiling thickness adapter for 10,000LM and above (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
CTA4-8 YK	Ceiling thickness adapter for 8,000LM and below (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
GVRT	Vandal-resistant trim accessory. Refer to TECH-200.
ISD BC	0-10V wallbox dimmer. Refer to ISD-BC.

ORDERING NOTES

1. Not available with finishes.
2. Not available with emergency battery pack options.
3. Supplied with factory installed step down transformer.
4. Refer to TECH-240 for compatible dimmers.
5. Not available with nLight® and XPoint options.
6. Specify voltage.
7. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with WR (white reflector) or FL (flangeless) option.
8. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with BR (black reflector) or FL (flangeless) option.
9. ER for use with generator supply power. Will require an emergency hot feed and normal hot feed.
10. Fixture begins at 80% light level. Must be specified with NLT or NLTER. Only available with EZ10 and EZ1 drivers.
11. 12,000LM max with EL or nLight® options. 5,000LM max with Lutron drivers combined with EL. Not available with ELR, HAO, EXA1, or EXAB options.
12. Only available 5000LM - 15,000LM with eldoLED drivers.
13. Not available DALI or DMX drivers. Not available with CP or N80 options. Not recommended for metal ceiling installations.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com

gotham®

SPECIFICATIONS

Optical Assembly
Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.
Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top-down flash characteristic for superior glare control.
Unitized optics shall have mechanical attachment of the light engine to the lower reflector for complete optical alignment.

Electrical
The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.
Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages.
Input wires shall be 18AWG, 300V minimum, solid copper.

Controls
Luminaire shall be equipped with interface for nLight wired or wireless network with integral power supply as per specification.

Dimming
The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 10%, 100 – 1.0% or 100 – 0.1% of rated lumen output with a smooth shut off function to step to 0%.
eldoLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered.
Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction
Luminaire housing shall be constructed of 16-gauge galvanized steel and have preinstalled telescopic mounting bars with maximum 32" and minimum 15" extension and 4" vertical adjustment.
Luminaires shall be suitable for installation in ceilings up to 1½" thick. (specify ceiling thickness adapter to extend frame to accommodate ceiling thickness up to 5").
Tool-less adjustments shall be possible after installation.
The assembly and manufacturing process for the luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.
25°C ambient temperature standard (1/2" clearance on all sides from non-combustible materials in non-IC applications, unless marked spacing noted otherwise). For use in insulated ceilings, a 3" clearance on all sides from insulation is required (unless marked spacing noted otherwise). 40°C high ambient optional.

Listings
Fixtures are CSA certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, wet location covered ceiling. Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.

Photometrics
LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.
Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by a point at the intersection of the CCT line and the black body locus line in CIE chromaticity space.

Warranty
5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note:
Actual performance may differ as a result of end user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.
*See ordering tree for details

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com

Marked Spacing in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
500-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000			9
12000			
15000			
17500	72	36	

Marked Spacing in Inches 40°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
5000	24	12	5
6000			
8000	48	24	9
10000			
12000			
15000	72	36	9

Marked Spacing Chicago Plenum Open Frame in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
250-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000			9
12000			
15000			
17500	72	36	

Marked Spacing Chicago Plenum Enclosure in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
250-6000	None	None	None
8000	36	18	6
10000	48	24	3
12000			

EVO - eldoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EXA1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic	Linear
EXAB	<1%	Logarithmic	Linear
EDXB	<1%	Square	Linear

Lumen Output Multiplier		
CRI	CCT	Multplier
80	2700K	0.96
	300K	1.00
	3500K	1.00
	4000K	1.01
	5000K	1.07
90	2700K	0.80
	300K	0.83
	3500K	0.85
	4000K	0.87
	5000K	0.91

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73

Distributions		
Nomenclature	Beam Angle	Field Angle
VND	30	64
ND	44	69
MD	54	82
MWD	67	89
WD	71	92

Driver		Control Provided (note: 347V/UVOLT versions provided with 347 option selected)			
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIRER2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ10	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ1	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZB	eldoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2

How to Estimate Delivered Lumens in Emergency Mode

Delivered Lumens = 1.25 x P x LPW

P = Output power of emergency driver. P = 10W for PS1055CP

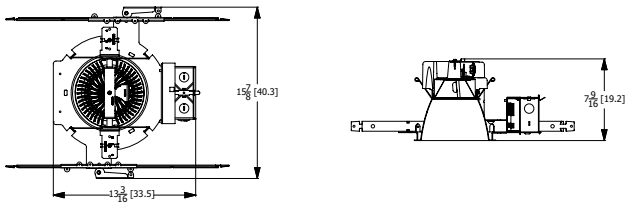
LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.

DIMENSIONAL DATA

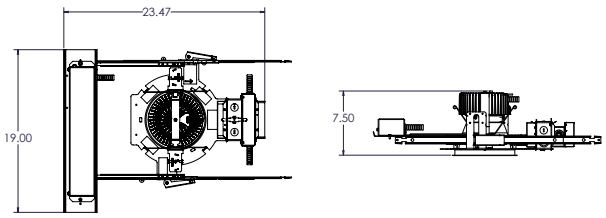
*Dimensions in inches [centimeters]

Aperture: 6 1/4" [15.9)]	Ceiling Opening: 7 1/8" [18.1] self-flanged
Overlap Trim: 7 1/2" [19.1]	7 1/4" [18.4] flangeless

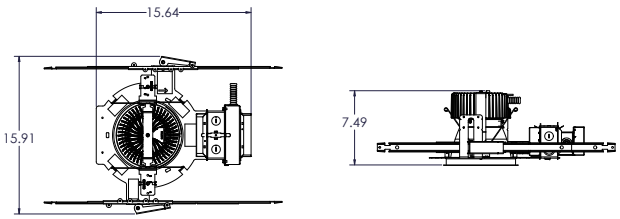
1000LM-4500LM Standard



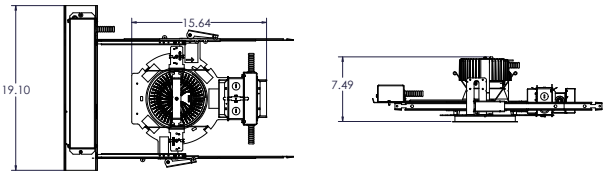
1000LM-4500LM Battery Pack



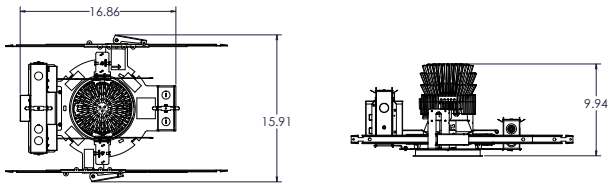
5000LM-8000LM Standard



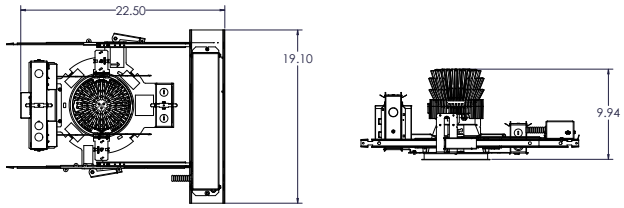
5000LM-8000LM Battery Pack



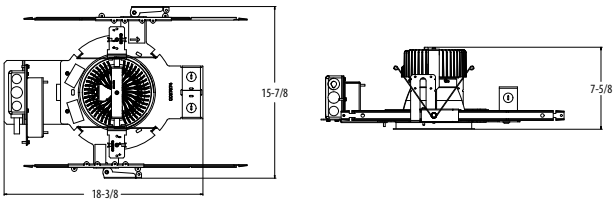
10,000LM-17,500LM Standard



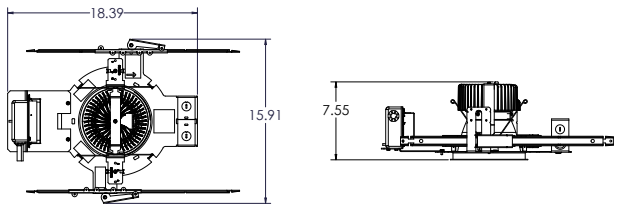
10,000LM-17,500LM Battery Pack



1000LM-4500LM CP



5000 Lumen ECO/SOLO Drive Open Frame CP



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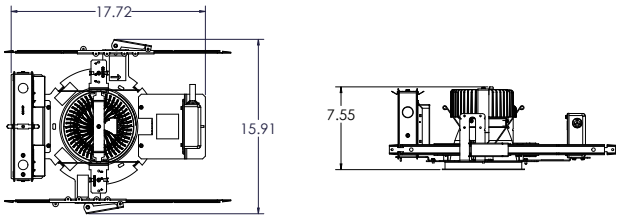
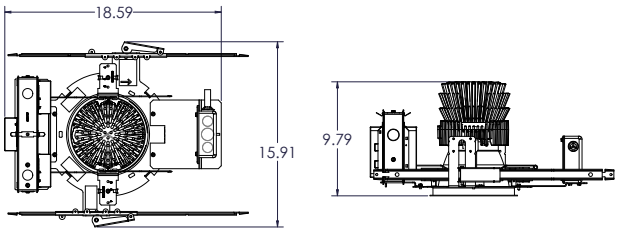
DIMENSIONAL DATA

*Dimensions in inches [centimeters]

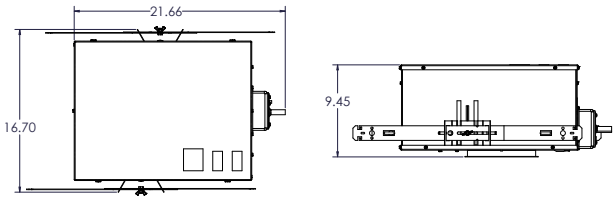
5000 (Lutron & POWER Drive Only), 6000 & 8000 Lumen Open Frame CP



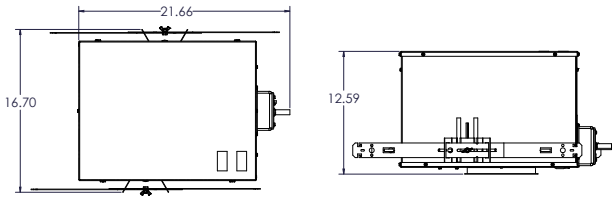
10000 - 17,500 Lumen Open Frame CP



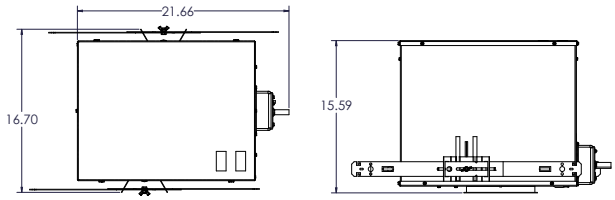
250 - 6000 Lumen CP for nLight® or Battery Pack



8,000LM Enclosed CP for nLight or Battery Pack



10,000LM-12,000LM Enclosed CP for nLight or Battery Pack



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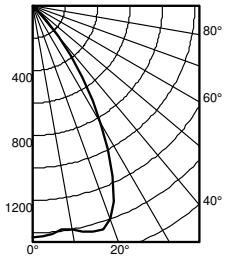
EV06 35/15 AR MWD LS INPUT WATTS: 14.7, DELIVERED LUMENS: 1471LM, LPW= 100, 1.03 S/MH, TEST NO. LTL27783P1505



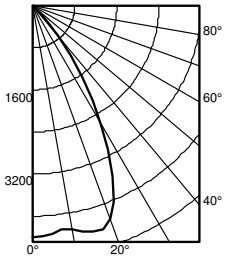
	Ave	Lumens
0	1431	
5	1410	134
15	1442	405
25	1161	523
35	540	332
45	78	72
55	3	4
65	1	1
75	0	1
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	1061.4	72.2
0° - 40°	1393.5	94.7
0° - 60°	1469.5	99.9
0° - 90°	1470.9	100.0
90° - 180°	0.0	0.0
0° - 180°	1470.9	*100.0
	*Efficiency	

pf / pc / pw	20% 80% 50%	20% 80% 30%	20% 80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	20% 50% 50%	20% 50% 30%	20% 50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	105	103	101
2	103	99	96	101	98	95	98	95	93
3	96	91	87	95	90	87	92	88	85
4	90	84	80	89	84	80	87	82	79
5	84	78	74	83	78	74	81	77	73
6	79	73	69	78	73	69	77	72	68
7	74	68	64	74	68	64	72	67	63
8	70	64	60	69	64	60	68	63	59
9	66	60	56	65	60	56	64	59	56
10	62	56	52	62	56	52	61	56	52

Mounting Height	Inital FC Center Beam	50% beam - 54.4° Diameter	50% beam - 54.4° FC	10% beam - 77.9° Diameter	10% beam - 77.9° FC
8.0	47.3	5.7	23.7	8.9	4.7
10.0	25.4	7.7	12.7	12.1	2.5
12.0	15.9	9.8	7.9	15.3	1.6
14.0	10.8	11.8	5.4	18.6	1.1
16.0	7.9	13.9	3.9	21.8	0.8

EV06 35/45 AR MWD LS INPUT WATTS: 47.3, DELIVERED LUMENS: 4532.7LM, LPW= 95.8, 1.03 S/MH, TEST NO. LTL27783P1649



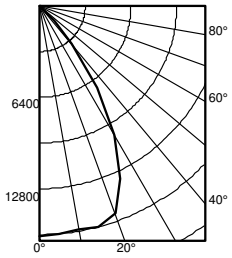
	Ave	Lumens
0	4411	
5	4346	413
15	4443	1247
25	3578	1610
35	1665	1024
45	242	222
55	8	12
65	2	3
75	1	2
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	3270.7	72.2
0° - 40°	4294.2	94.7
0° - 60°	4528.3	99.9
0° - 90°	4532.7	100.0
90° - 180°	0.0	0.0
0° - 180°	4532.7	*100.0
	*Efficiency	

pf / pc / pw	20% 80% 50%	20% 80% 30%	20% 80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	20% 50% 50%	20% 50% 30%	20% 50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	105	103	101
2	103	99	96	101	98	95	98	95	93
3	96	91	87	95	90	87	92	88	85
4	90	84	80	89	84	80	87	82	79
5	84	78	74	83	78	74	81	77	73
6	79	73	69	78	73	69	77	72	68
7	74	68	64	74	68	64	72	67	63
8	70	64	60	69	64	60	68	63	59
9	66	60	56	65	60	56	64	59	56
10	62	56	52	62	56	52	61	56	52

Mounting Height	Inital FC Center Beam	50% beam - 54.4° Diameter	50% beam - 54.4° FC	10% beam - 77.9° Diameter	10% beam - 77.9° FC
8.0	145.8	5.7	72.9	8.9	14.6
10.0	78.4	7.7	39.2	12.1	7.8
12.0	48.9	9.8	24.4	15.3	4.9
14.0	33.4	11.8	16.7	18.6	3.3
16.0	24.2	13.9	12.1	21.8	2.4

EV06 35/175 AR MWD LS INPUT WATTS: 175.3, DELIVERED LUMENS: 17801LM, LPW=101.5, 1.06 S/MH, TEST NO. ISF 34035P268



	Ave	Lumens
0	16146	
5	15998	1521
15	16006	4479
25	13362	6001
35	7018	4289
45	1470	1299
55	100	156
65	37	38
75	13	14
85	2	2
90	0	

Zone	Lumens	% Lamp
0° - 30°	12002.3	67.4
0° - 40°	16291.0	91.5
0° - 60°	17746.3	99.7
0° - 90°	17801.0	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	17801.0	*100.0
	*Efficiency	

pf / pc / pw	20% 80% 50%	20% 80% 30%	20% 80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	20% 50% 50%	20% 50% 30%	20% 50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	108	106	104	104	103	101
2	103	98	95	101	97	94	98	95	92
3	95	90	86	94	89	86	91	87	84
4	89	83	79	88	82	78	85	81	77
5	83	77	72	82	76	72	80	75	71
6	77	71	67	77	71	67	75	70	66
7	73	66	62	72	66	62	71	65	61
8	68	62	58	67	62	57	66	61	57
9	64	58	54	63	58	54	62	57	53
10	60	54	50	60	54	50	59	54	50

Mounting Height	Inital FC Center Beam	50% beam - 55.7° Diameter	50% beam - 55.7° FC	10% beam - 79.8° Diameter	10% beam - 79.8° FC
8.0	533.7	5.8	266.9	9.2	53.4
10.0	287.0	7.9	143.5	12.5	28.7
12.0	178.9	10.0	89.4	15.9	17.9
14.0	122.1	12.1	61.0	19.2	12.2
16.0	88.6	14.3	44.3	22.6	8.9

gotham®

gotham® | EVO®

Multiple Layers of Light

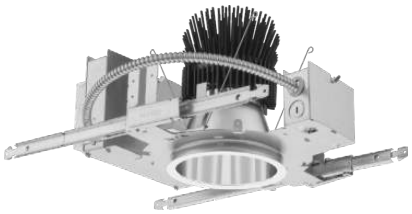
Luminaire Type: L7B

Catalog Number:

Approved Alternate Manufacturers:
Portfolio "LD6A10" Series
Indy "L6" Series
Vantage 6" Downlight

General Illumination Round Downlight 6"

250 - 8,000 lumens



10,000 - 17,500 lumens

OVERVIEW

Feature Set

- Bounding Ray™ optical design
- Unitized optics mechanically attach the light engine to the lower reflector for complete optical alignment.
- 45° cutoff to source and source image
- Fully serviceable and upgradeable lensed LED light engine
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling
- Available with 10% dimming, 1% dimming, or dim to dark
- Batwing distribution with feathered edges provides even illumination on horizontal and vertical surfaces
- ENERGY STAR® certified product

Distribution

Superior Performance

Nominal Lumens	250	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000	6000	8000	10,000	12,000	15,000	17,500
Delivered Lumens	297	519	776	994	1471	2006	2537	3077	3542	4027	4533	5256	6371	8247	10637	12332	15776	17801
Wattage	3.4	6.2	8.2	9.6	14.7	19.7	24.7	29.5	33.8	39.0	47.3	48.7	57.6	74.9	97.1	115.0	150.9	175.3
Lumens per Watt	87.4	83.7	94.6	103.5	100.1	101.8	102.7	104.3	104.8	103.3	95.8	107.9	110.6	110.1	109.5	107.2	104.5	101.5

COMPLIMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light

General Illumination Layer | EVO

High Center Beam Layer | Incito

EVO + Incito — Multiple Layers of Light

Core

Healthcare

Special Applications

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com

gotham® | EVO®

6" General Illumination Round Downlight

ORDERING INFORMATION

A+ Capable options indicated by this color background.

Design2Ship Quick Ship Program: Options in green text qualify for Design2Ship — 5 business days from order entry to ship. Refer to Design2Ship Brochure for complete program details. **Maximum Order Quantity: 100 units; 50 for Chicago Plenum.**

Luminaire Type: L7B

Catalog Number:

EXAMPLE: EVO6 35/150 AR MWD LSS MVOLT EZ1

Series	Color Temperature	Nominal Lumen Values	Reflector & Flange Color	Trim Style	Distribution
EVO6	27/ 2700 K 30/ 3000 K 35/ 3500 K 40/ 4000 K 50/ 5000 K	02 250 lumens 05 500 lumens 07 750 lumens 10 1000 lumens 15 1500 lumens 20 2000 lumens 25 2500 lumens 30 3000 lumens 35 3500 lumens 40 4000 lumens 45 4500 lumens 50 5000 lumens 60 6000 lumens 80 8000 lumens 100 10000 lumens 120 12000 lumens 150 15000 lumens 175 17500 lumens	AR Clear PR Pewter WTR Wheat GR Gold WR[1] White BR[1] Black WRAMF[1] White Anti-microbial	(blank) Self-flanged FL Flangeless	VND Very Narrow (0.5 s/mh) ND Narrow (0.7 s/mh) MD Medium (0.9 s/mh) MWD Medium Wide (1.0 s/mh) WD Wide (1.2 s/mh)

Finish	Voltage	Driver[4]
LSS Semi-specular LD Matte-diffuse LS Specular	MVOLT 120 277 347[2,3]	GZ10 0-10V driver dims to 10% GZ1 0-10V driver dims to 1% EZ10 eldoLED 0-10V ECOdrive. Linear dimming to 10% min. EZ1 eldoLED 0-10V ECOdrive. Linear dimming to 1% min. EZB eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%. EDAB[5] eldoLED SOLOdrive DALI. Logarithmic dimming to <1%. EDXB[5] eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Includes termination resistor. Refer to DMXR Manual. Minimum 1000 lumens/Maximum 15000 lumens. ECOS2[5] Lutron® Hi-Lume® 2-wire forward-phase driver. Minimum dimming level 1%, 120V only. Minimum 1000 lumens/Maximum 4000 lumens. ECOD[5] Lutron Ecosystem digital Hi-Lume 1% soft-on, fade to black. Max: 4000LM.

PROVIDE FOR EM ONLY

Control Interface	Options	
NLT[6] nLight® dimming pack controls NLTER[2,6,9] nLight® dimming pack controls emergency circuit NLTAIR2[13] nLight® AIR enabled NLTAIRER2[2,9,13] nLight® AIR enabled emergency EXA1 XPoint Wireless, eldoLED driver. Linear dimming to 1% EXAB XPoint Wireless, eldoLED driver. Logarithmic dimming to dark	SF Single fuse. Specify 120V or 277V. TRW[7] White painted flange TRBL[8] Black painted flange EL Emergency battery pack, 10W, with integral test switch ELR Emergency battery pack, 10W, with self-diagnostics, with remote test switch ELSD Emergency battery pack, 10W, with self-diagnostics, integral test switch ELRSD Emergency battery pack, 10W, with self-diagnostics, remote test switch E10WCP Emergency battery pack, 10W Constant Power, CA Title 20 compliant with integral test switch E10WCPR Emergency battery pack, 10W Constant Power, CA Title 20 compliant with remote test switch	N80[10] nLight® Lumen Compensation BGTD Bodine generator transfer device. Specify 120V or 277V. 90CRI High CRI (90+) CP[11] Chicago Plenum. Specify 120V or 277V for 5000lm and above. HAO[12] HAO High Ambient Option (40°C) RRL_ RELOC®-ready luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Refer to RRL for complete nomenclature

ACCESSORIES – order as separate catalog numbers (shipped separately)

SCA6	Sloped ceiling adapter. Degree of slope must be specified (5D, 10D, 15D, 20D, 25D, 30D). Ex: SCA6 10D. Refer to TECH-190.
CTA4-8 YKHL	Ceiling thickness adapter for 10,000LM and above (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
CTA4-8 YK	Ceiling thickness adapter for 8,000LM and below (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
GVRT	Vandal-resistant trim accessory. Refer to TECH-200.
ISD BC	0-10V wallbox dimmer. Refer to ISD-BC.

ORDERING NOTES

1. Not available with finishes.
2. Not available with emergency battery pack options.
3. Supplied with factory installed step down transformer.
4. Refer to TECH-240 for compatible dimmers.
5. Not available with nLight® and XPoint options.
6. Specify voltage.
7. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with WR (white reflector) or FL (flangeless) option.
8. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with BR (black reflector) or FL (flangeless) option.
9. ER for use with generator supply power. Will require an emergency hot feed and normal hot feed.
10. Fixture begins at 80% light level. Must be specified with NLT or NLTER. Only available with EZ10 and EZ1 drivers.
11. 12,000LM max with EL or nLight® options. 5,000LM max with Lutron drivers combined with EL. Not available with ELR, HAO, EXA1, or EXAB options.
12. Only available 5000LM - 15,000LM with eldoLED drivers.
13. Not available DALI or DMX drivers. Not available with CP or N80 options. Not recommended for metal ceiling installations.

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SPECIFICATIONS

Optical Assembly
Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.
Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top-down flash characteristic for superior glare control.
Unitized optics shall have mechanical attachment of the light engine to the lower reflector for complete optical alignment.

Electrical
The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.
Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages.
Input wires shall be 18AWG, 300V minimum, solid copper.

Controls
Luminaire shall be equipped with interface for nLight wired or wireless network with integral power supply as per specification.

Dimming
The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 10%, 100 – 1.0% or 100 – 0.1% of rated lumen output with a smooth shut off function to step to 0%.
eldoLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered.
Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction
Luminaire housing shall be constructed of 16-gauge galvanized steel and have preinstalled telescopic mounting bars with maximum 32" and minimum 15" extension and 4" vertical adjustment.
Luminaires shall be suitable for installation in ceilings up to 1½" thick. (specify ceiling thickness adapter to extend frame to accommodate ceiling thickness up to 5").
Tool-less adjustments shall be possible after installation.
The assembly and manufacturing process for the luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.
25°C ambient temperature standard (1/2" clearance on all sides from non-combustible materials in non-IC applications, unless marked spacing noted otherwise). For use in insulated ceilings, a 3" clearance on all sides from insulation is required (unless marked spacing noted otherwise). 40°C high ambient optional.

Listings
Fixtures are CSA certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, wet location covered ceiling. Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.

Photometrics
LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.
Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by a point at the intersection of the CCT line and the black body locus line in CIE chromaticity space.

Warranty
5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note:
Actual performance may differ as a result of end user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.
*See ordering tree for details

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Tables of Use

Marked Spacing in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
500-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000			9
12000			
15000			
17500	72	36	

Marked Spacing in Inches 40°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
5000	24	12	5
6000			
8000	48	24	9
10000			
12000			
15000	72	36	9

Marked Spacing Chicago Plenum Open Frame in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
250-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000			9
12000			
15000			
17500	72	36	

Marked Spacing Chicago Plenum Enclosure in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
250-6000	None	None	None
8000	36	18	6
10000	48	24	3
12000			

EVO - eldoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EXA1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic	Linear
EXAB	<1%	Logarithmic	Linear
EDXB	<1%	Square	Linear

Lumen Output Multiplier		
CRI	CCT	Multplier
80	2700K	0.96
	300K	1.00
	3500K	1.00
	4000K	1.01
	5000K	1.07
90	2700K	0.80
	300K	0.83
	3500K	0.85
	4000K	0.87
	5000K	0.91

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73

Distributions		
Nomenclature	Beam Angle	Field Angle
VND	30	64
ND	44	69
MD	54	82
MWD	67	89
WD	71	92

Driver		Control Provided (note: 347V/UVOLT versions provided with 347 option selected)			
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIRER2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ10	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ1	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZB	eldoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2

How to Estimate Delivered Lumens in Emergency Mode

Delivered Lumens = 1.25 x P x LPW

P = Output power of emergency driver. P = 10W for PS1055CP

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.

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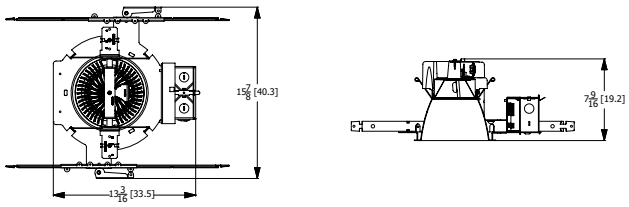
DIMENSIONAL DATA

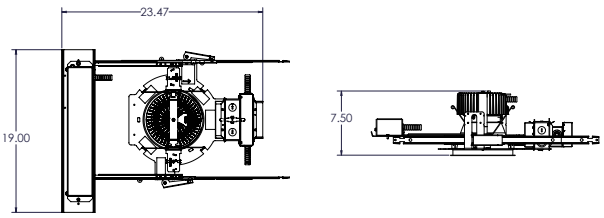
*Dimensions in inches [centimeters]

Aperture: 6 1/4" [15.9)]	Ceiling Opening: 7 1/8" [18.1] self-flanged
Overlap Trim: 7 1/2" [19.1]	7 1/4" [18.4] flangeless

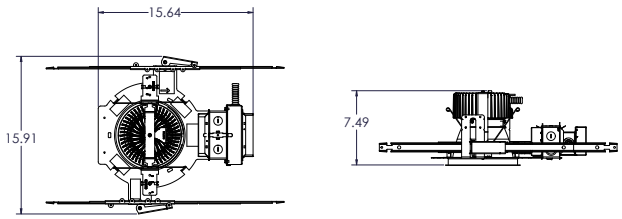
1000LM-4500LM Standard



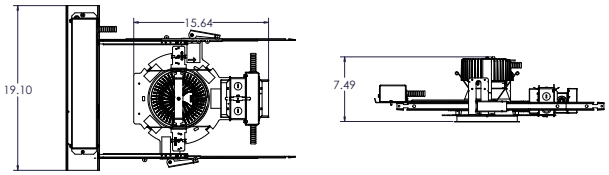
1000LM-4500LM Battery Pack



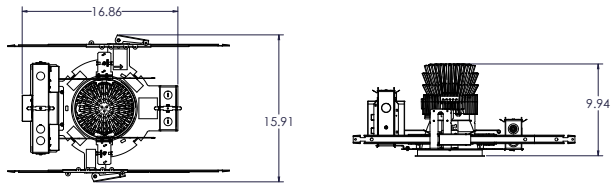
5000LM-8000LM Standard



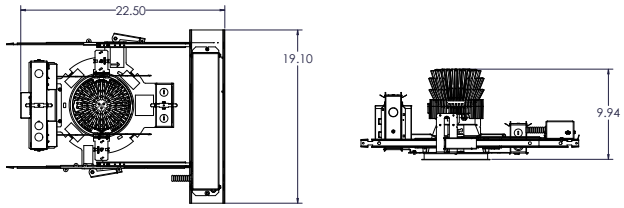
5000LM-8000LM Battery Pack



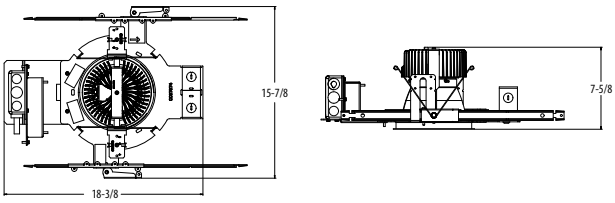
10,000LM-17,500LM Standard



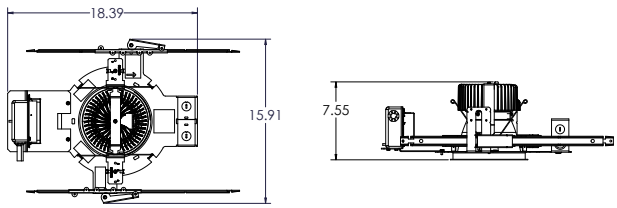
10,000LM-17,500LM Battery Pack



1000LM-4500LM CP



5000 Lumen ECO/SOLO Drive Open Frame CP



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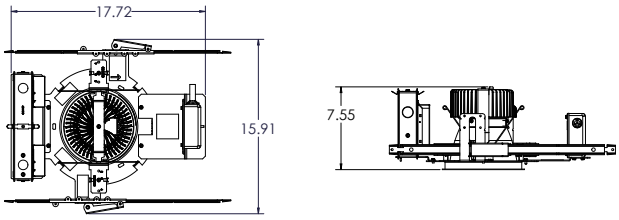
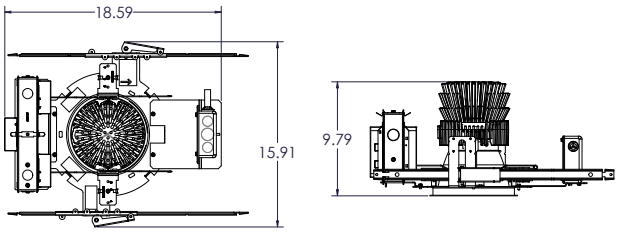
DIMENSIONAL DATA

*Dimensions in inches [centimeters]

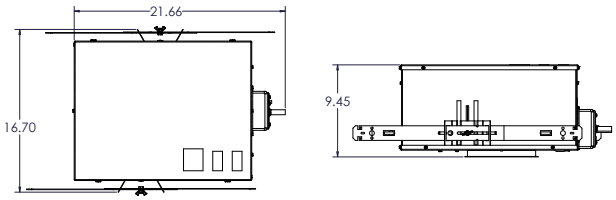
5000 (Lutron & POWER Drive Only), 6000 & 8000 Lumen Open Frame CP



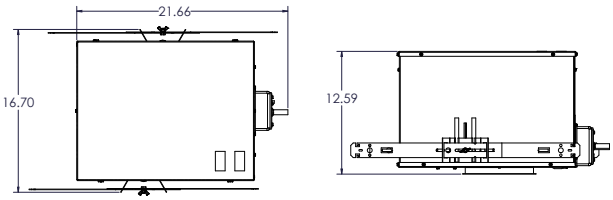
10000 - 17,500 Lumen Open Frame CP



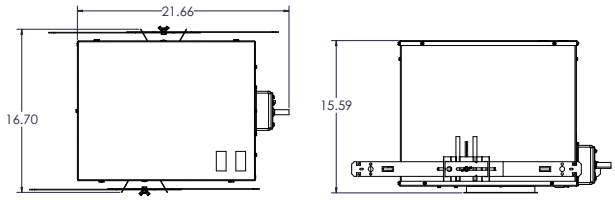
250 - 6000 Lumen CP for nLight® or Battery Pack



8,000LM Enclosed CP for nLight or Battery Pack



10,000LM-12,000LM Enclosed CP for nLight or Battery Pack



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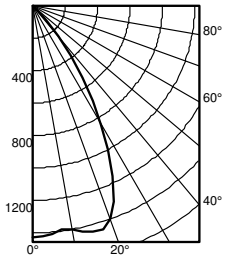
EV06 35/15 AR MWD LS INPUT WATTS: 14.7, DELIVERED LUMENS: 1471LM, LPW= 100, 1.03 S/MH, TEST NO. LTL27783P1505



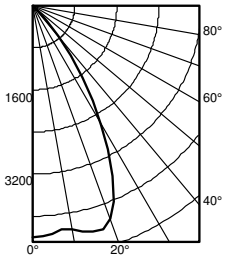
	Ave	Lumens
0	1431	
5	1410	134
15	1442	405
25	1161	523
35	540	332
45	78	72
55	3	4
65	1	1
75	0	1
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	1061.4	72.2
0° - 40°	1393.5	94.7
0° - 60°	1469.5	99.9
0° - 90°	1470.9	100.0
90° - 180°	0.0	0.0
0° - 180°	1470.9	*100.0
	*Efficiency	

pf / pc / pw	20% 80% 50%	20% 80% 30%	20% 80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	20% 50% 50%	20% 50% 30%	20% 50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	105	103	101
2	103	99	96	101	98	95	98	95	93
3	96	91	87	95	90	87	92	88	85
4	90	84	80	89	84	80	87	82	79
5	84	78	74	83	78	74	81	77	73
6	79	73	69	78	73	69	77	72	68
7	74	68	64	74	68	64	72	67	63
8	70	64	60	69	64	60	68	63	59
9	66	60	56	65	60	56	64	59	56
10	62	56	52	62	56	52	61	56	52

Mounting Height	Inital FC Center Beam	50% beam - 54.4° Diameter	50% beam - 54.4° FC	10% beam - 77.9° Diameter	10% beam - 77.9° FC
8.0	47.3	5.7	23.7	8.9	4.7
10.0	25.4	7.7	12.7	12.1	2.5
12.0	15.9	9.8	7.9	15.3	1.6
14.0	10.8	11.8	5.4	18.6	1.1
16.0	7.9	13.9	3.9	21.8	0.8

EV06 35/45 AR MWD LS INPUT WATTS: 47.3, DELIVERED LUMENS: 4532.7LM, LPW= 95.8, 1.03 S/MH, TEST NO. LTL27783P1649



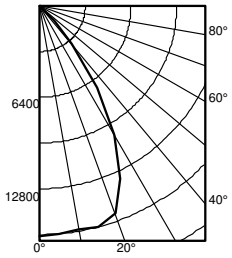
	Ave	Lumens
0	4411	
5	4346	413
15	4443	1247
25	3578	1610
35	1665	1024
45	242	222
55	8	12
65	2	3
75	1	2
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	3270.7	72.2
0° - 40°	4294.2	94.7
0° - 60°	4528.3	99.9
0° - 90°	4532.7	100.0
90° - 180°	0.0	0.0
0° - 180°	4532.7	*100.0
	*Efficiency	

pf / pc / pw	20% 80% 50%	20% 80% 30%	20% 80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	20% 50% 50%	20% 50% 30%	20% 50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	105	103	101
2	103	99	96	101	98	95	98	95	93
3	96	91	87	95	90	87	92	88	85
4	90	84	80	89	84	80	87	82	79
5	84	78	74	83	78	74	81	77	73
6	79	73	69	78	73	69	77	72	68
7	74	68	64	74	68	64	72	67	63
8	70	64	60	69	64	60	68	63	59
9	66	60	56	65	60	56	64	59	56
10	62	56	52	62	56	52	61	56	52

Mounting Height	Inital FC Center Beam	50% beam - 54.4° Diameter	50% beam - 54.4° FC	10% beam - 77.9° Diameter	10% beam - 77.9° FC
8.0	145.8	5.7	72.9	8.9	14.6
10.0	78.4	7.7	39.2	12.1	7.8
12.0	48.9	9.8	24.4	15.3	4.9
14.0	33.4	11.8	16.7	18.6	3.3
16.0	24.2	13.9	12.1	21.8	2.4

EV06 35/175 AR MWD LS INPUT WATTS: 175.3, DELIVERED LUMENS: 17801LM, LPW=101.5, 1.06 S/MH, TEST NO. ISF 34035P268



	Ave	Lumens
0	16146	
5	15998	1521
15	16006	4479
25	13362	6001
35	7018	4289
45	1470	1299
55	100	156
65	37	38
75	13	14
85	2	2
90	0	

Zone	Lumens	% Lamp
0° - 30°	12002.3	67.4
0° - 40°	16291.0	91.5
0° - 60°	17746.3	99.7
0° - 90°	17801.0	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	17801.0	*100.0
	*Efficiency	

pf / pc / pw	20% 80% 50%	20% 80% 30%	20% 80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	20% 50% 50%	20% 50% 30%	20% 50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	108	106	104	104	103	101
2	103	98	95	101	97	94	98	95	92
3	95	90	86	94	89	86	91	87	84
4	89	83	79	88	82	78	85	81	77
5	83	77	72	82	76	72	80	75	71
6	77	71	67	77	71	67	75	70	66
7	73	66	62	72	66	62	71	65	61
8	68	62	58	67	62	57	66	61	57
9	64	58	54	63	58	54	62	57	53
10	60	54	50	60	54	50	59	54	50

Mounting Height	Inital FC Center Beam	50% beam - 55.7° Diameter	50% beam - 55.7° FC	10% beam - 79.8° Diameter	10% beam - 79.8° FC
8.0	533.7	5.8	266.9	9.2	53.4
10.0	287.0	7.9	143.5	12.5	28.7
12.0	178.9	10.0	89.4	15.9	17.9
14.0	122.1	12.1	61.0	19.2	12.2
16.0	88.6	14.3	44.3	22.6	8.9

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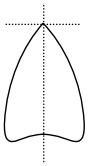
Multiple Layers of Light



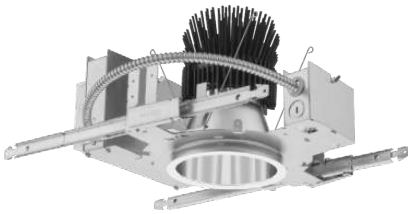
Luminaire Type: L7C

Catalog Number:

Approved Alternate Manufacturers:
Portfolio "LD6A10" Series
Indy "L6" Series
Vantage 6" Downlight

General Illumination Round Downlight 6"

250 - 8,000 lumens



10,000 - 17,500 lumens

OVERVIEW

Feature Set

- Bounding Ray™ optical design
- Unitized optics mechanically attach the light engine to the lower reflector for complete optical alignment.
- 45° cutoff to source and source image
- Fully serviceable and upgradeable lensed LED light engine
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling
- Available with 10% dimming, 1% dimming, or dim to dark
- Batwing distribution with feathered edges provides even illumination on horizontal and vertical surfaces
- ENERGY STAR® certified product

Distribution

Superior Performance

Nominal Lumens	250	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000	6000	8000	10,000	12,000	15,000	17,500
Delivered Lumens	297	519	776	994	1471	2006	2537	3077	3542	4027	4533	5256	6371	8247	10637	12332	15776	17801
Wattage	3.4	6.2	8.2	9.6	14.7	19.7	24.7	29.5	33.8	39.0	47.3	48.7	57.6	74.9	97.1	115.0	150.9	175.3
Lumens per Watt	87.4	83.7	94.6	103.5	100.1	101.8	102.7	104.3	104.8	103.3	95.8	107.9	110.6	110.1	109.5	107.2	104.5	101.5

COMPLIMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light

General Illumination Layer | EVO

High Center Beam Layer | Incito

EVO + Incito — Multiple Layers of Light

Core

Healthcare

Special Applications

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6" General Illumination Round Downlight

ORDERING INFORMATION

A+ Capable options indicated by this color background.

Design2Ship Quick Ship Program: Options in green text qualify for Design2Ship — 5 business days from order entry to ship. Refer to Design2Ship Brochure for complete program details. **Maximum Order Quantity: 100 units; 50 for Chicago Plenum.**

Luminaire Type: L7C

Catalog Number:

EXAMPLE: EV06 35/150 AR MWD LSS MVOLT EZ1

Series	Color Temperature	Nominal Lumen Values	Reflector & Flange Color	Trim Style	Distribution
EV06	27/ 2700 K 30/ 3000 K 35/ 3500 K 40/ 4000 K 50/ 5000 K	02 250 lumens 05 500 lumens 07 750 lumens 10 1000 lumens 15 1500 lumens 20 2000 lumens 25 2500 lumens 30 3000 lumens 35 3500 lumens 40 4000 lumens 45 4500 lumens 50 5000 lumens 60 6000 lumens 80 8000 lumens 100 10000 lumens 120 12000 lumens 150 15000 lumens 175 17500 lumens	AR Clear PR Pewter WTR Wheat GR Gold WR[1] White BR[1] Black WRAMF[1] White Anti-microbial	(blank) Self-flanged FL Flangeless	VND Very Narrow (0.5 s/mh) ND Narrow (0.7 s/mh) MD Medium (0.9 s/mh) MWD Medium Wide (1.0 s/mh) WD Wide (1.2 s/mh)

Finish	Voltage	Driver[4]	
LSS Semi-specular LD Matte-diffuse LS Specular	MVOLT 120 277 347[2,3]	GZ10 0-10V driver dims to 10% GZ1 0-10V driver dims to 1% EZ10 eldoLED 0-10V ECOdrive. Linear dimming to 10% min. EZ1 eldoLED 0-10V ECOdrive. Linear dimming to 1% min. EZB eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%. EDAB[5] eldoLED SOLOdrive DALI. Logarithmic dimming to <1%. EDXB[5] eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Includes termination resistor. Refer to DMXR Manual. Minimum 1000 lumens/Maximum 15000 lumens.	ECOS2[5] Lutron® Hi-Lume® 2-wire forward-phase driver. Minimum dimming level 1%, 120V only. Minimum 1000 lumens/Maximum 4000 lumens. ECOD[5] Lutron Ecosystem digital Hi-Lume 1% soft-on, fade to black. Max: 4000LM.

Control Interface	Options	
NLT[6] nLight® dimming pack controls NLTER[2,6,9] nLight® dimming pack controls emergency circuit NLTAIR2[13] nLight® AIR enabled NLTAIRER2[2,9,13] nLight® AIR enabled emergency EXA1 XPoint Wireless, eldoLED driver. Linear dimming to 1% EXAB XPoint Wireless, eldoLED driver. Logarithmic dimming to dark	SF Single fuse. Specify 120V or 277V. TRW[7] White painted flange TRBL[8] Black painted flange EL Emergency battery pack, 10W, with integral test switch ELR Emergency battery pack, 10W, with self-diagnostics, with remote test switch ELSD Emergency battery pack, 10W, with self-diagnostics, integral test switch ELRSD Emergency battery pack, 10W, with self-diagnostics, remote test switch E10WCP Emergency battery pack, 10W Constant Power, CA Title 20 compliant with integral test switch E10WCPR Emergency battery pack, 10W Constant Power, CA Title 20 compliant with remote test switch	N80[10] nLight® Lumen Compensation BGTD Bodine generator transfer device. Specify 120V or 277V. 90CRI High CRI (90+) CP[11] Chicago Plenum. Specify 120V or 277V for 5000lm and above. HAO[12] HAO High Ambient Option (40°C) RRL_ RELOC®-ready luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Refer to RRL for complete nomenclature

Provide for EM lights only

ACCESSORIES – order as separate catalog numbers (shipped separately)

SCA6	Sloped ceiling adapter. Degree of slope must be specified (5D, 10D, 15D, 20D, 25D, 30D). Ex: SCA6 10D. Refer to TECH-190.
CTA4-8 YKHL	Ceiling thickness adapter for 10,000LM and above (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
CTA4-8 YK	Ceiling thickness adapter for 8,000LM and below (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
GVRT	Vandal-resistant trim accessory. Refer to TECH-200.
ISD BC	0-10V wallbox dimmer. Refer to ISD-BC.

ORDERING NOTES

1. Not available with finishes.
2. Not available with emergency battery pack options.
3. Supplied with factory installed step down transformer.
4. Refer to TECH-240 for compatible dimmers.
5. Not available with nLight® and XPoint options.
6. Specify voltage.
7. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with WR (white reflector) or FL (flangeless) option.
8. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with BR (black reflector) or FL (flangeless) option.
9. ER for use with generator supply power. Will require an emergency hot feed and normal hot feed.
10. Fixture begins at 80% light level. Must be specified with NLT or NLTER. Only available with EZ10 and EZ1 drivers.
11. 12,000LM max with EL or nLight® options. 5,000LM max with Lutron drivers combined with EL. Not available with ELR, HAO, EXA1, or EXAB options.
12. Only available 5000LM - 15,000LM with eldoLED drivers.
13. Not available DALI or DMX drivers. Not available with CP or N80 options. Not recommended for metal ceiling installations.

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SPECIFICATIONS

Optical Assembly

Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.

Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top-down flash characteristic for superior glare control.

Unitized optics shall have mechanical attachment of the light engine to the lower reflector for complete optical alignment.

Electrical

The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.

The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages.

Input wires shall be 18AWG, 300V minimum, solid copper.

Controls

Luminaire shall be equipped with interface for nLight wired or wireless network with integral power supply as per specification.

Dimming

The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 10%, 100 – 1.0% or 100 – 0.1% of rated lumen output with a smooth shut off function to step to 0%.

eldoLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered.

Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction

Luminaire housing shall be constructed of 16-gauge galvanized steel and have preinstalled telescopic mounting bars with maximum 32" and minimum 15" extension and 4" vertical adjustment.

Luminaires shall be suitable for installation in ceilings up to 1½" thick. (specify ceiling thickness adapter to extend frame to accommodate ceiling thickness up to 5").

Tool-less adjustments shall be possible after installation.

The assembly and manufacturing process for the luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.

25°C ambient temperature standard (1/2" clearance on all sides from non-combustible materials in non-IC applications, unless marked spacing noted otherwise). For use in insulated ceilings, a 3" clearance on all sides from insulation is required (unless marked spacing noted otherwise). 40°C high ambient optional.

Listings

Fixtures are CSA certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, wet location covered ceiling. Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.

Photometrics

LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.

Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by a point at the intersection of the CCT line and the black body locus line in CIE chromaticity space.

Warranty

5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note:

Actual performance may differ as a result of end user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

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Tables of Use

Marked Spacing in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
500-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000			9
12000			
15000			
17500	72	36	

Marked Spacing in Inches 40°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
5000	24	12	5
6000			
8000	48	24	9
10000			
12000			
15000	72	36	9

Marked Spacing Chicago Plenum Open Frame in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
250-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000			9
12000			
15000			
17500	72	36	

Marked Spacing Chicago Plenum Enclosure in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
250-6000	None	None	None
8000	36	18	6
10000	48	24	3
12000			

EVO - eldoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EXA1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic	Linear
EXAB	<1%	Logarithmic	Linear
EDXB	<1%	Square	Linear

Lumen Output Multiplier		
CRI	CCT	Multplier
80	2700K	0.96
	300K	1.00
	3500K	1.00
	4000K	1.01
	5000K	1.07
90	2700K	0.80
	300K	0.83
	3500K	0.85
	4000K	0.87
	5000K	0.91

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73

Distributions		
Nomenclature	Beam Angle	Field Angle
VND	30	64
ND	44	69
MD	54	82
MWD	67	89
WD	71	92

Driver		Control Provided (note: 347V/UVOLT versions provided with 347 option selected)			
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIRER2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ10	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ1	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZB	eldoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2

How to Estimate Delivered Lumens in Emergency Mode

Delivered Lumens = 1.25 x P x LPW

P = Output power of emergency driver. P = 10W for PS1055CP

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.

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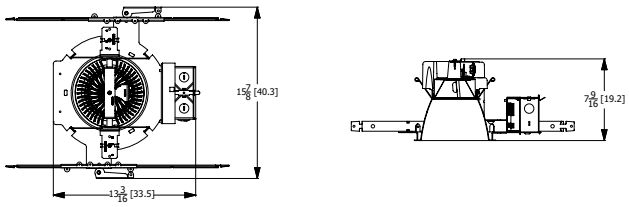
DIMENSIONAL DATA

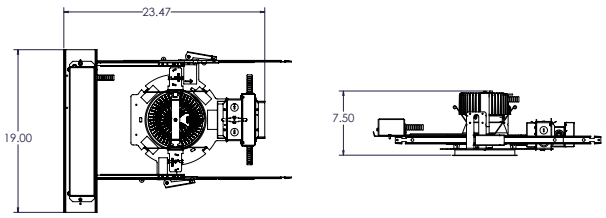
*Dimensions in inches [centimeters]

Aperture: 6 1/4" [15.9)]	Ceiling Opening: 7 1/8" [18.1] self-flanged
Overlap Trim: 7 1/2" [19.1]	7 1/4" [18.4] flangeless

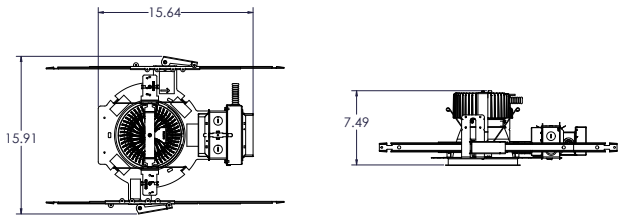
1000LM-4500LM Standard



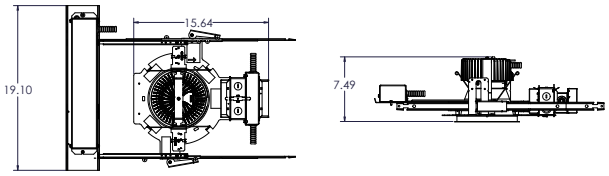
1000LM-4500LM Battery Pack



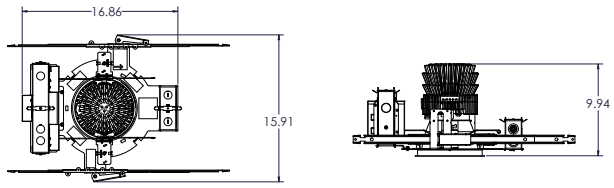
5000LM-8000LM Standard



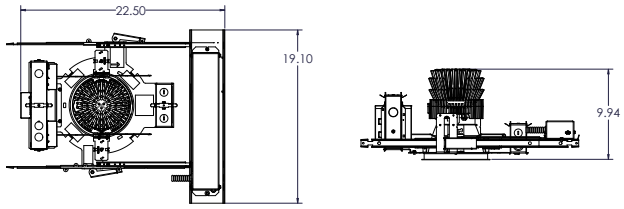
5000LM-8000LM Battery Pack



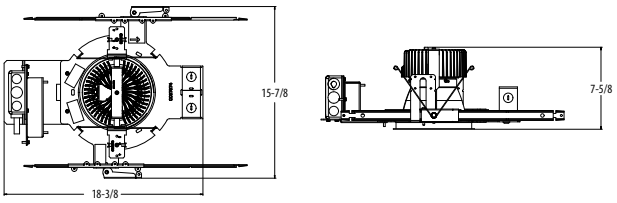
10,000LM-17,500LM Standard



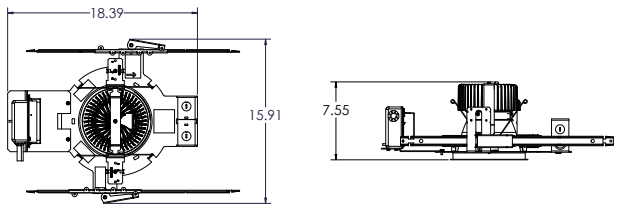
10,000LM-17,500LM Battery Pack



1000LM-4500LM CP



5000 Lumen ECO/SOLO Drive Open Frame CP



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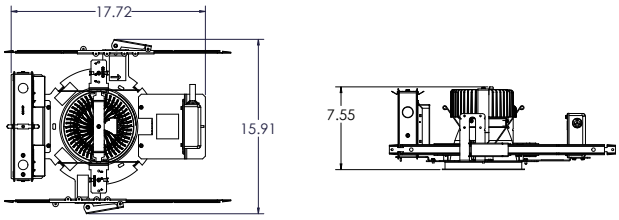
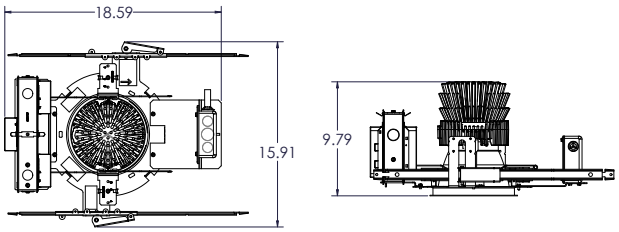
DIMENSIONAL DATA

*Dimensions in inches [centimeters]

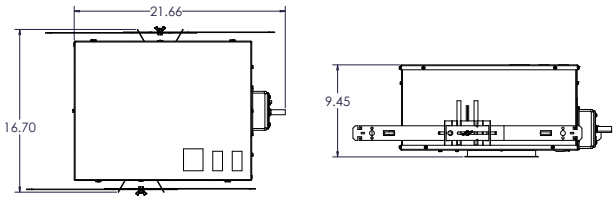
5000 (Lutron & POWER Drive Only), 6000 & 8000 Lumen Open Frame CP



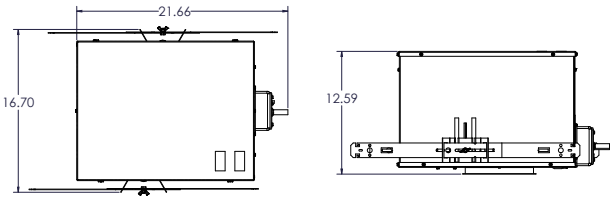
10000 - 17,500 Lumen Open Frame CP



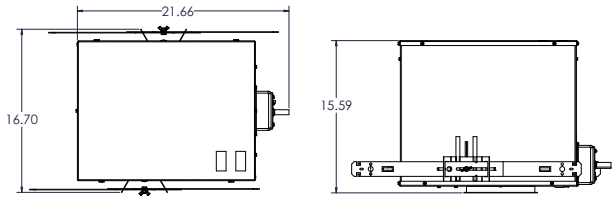
250 - 6000 Lumen CP for nLight® or Battery Pack



8,000LM Enclosed CP for nLight or Battery Pack



10,000LM-12,000LM Enclosed CP for nLight or Battery Pack



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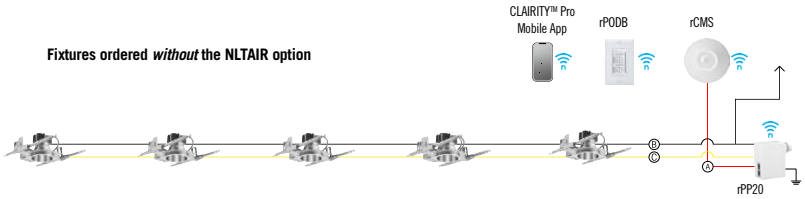
NLIGHT AIR

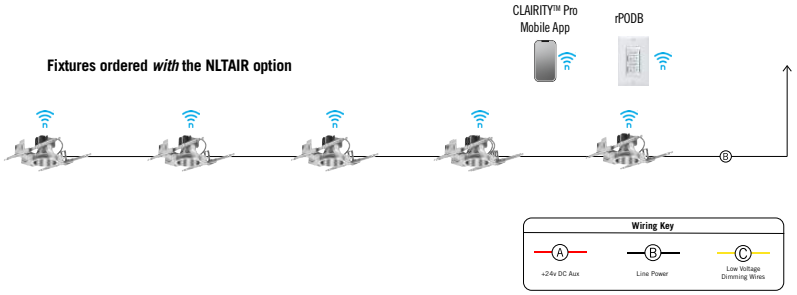
nLight® AIR is the ideal solution for retrofit or new construction spaces where adding communication wiring is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each EVO Luminaire ordered with the NLTAIR option. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.

Possibilites for nLight® AIR

Fixtures ordered *without* the NLTAIR option



Fixtures ordered *with* the NLTAIR option



nLight® AIR Control Accessories
Order as separate catalog number. Visit nLight AIR.

Wall Switches	Model Number
On/Off single pole	rPODB (color) G2
On/Off two pole	rPODB 2P (color) G2
On/Off & raise/lower single pole	rPODB DX (color) G2
On/Off & raise/lower two pole	rPODB 2P DX (color) G2

nLight® AIR Control Accessories *(cont.)*

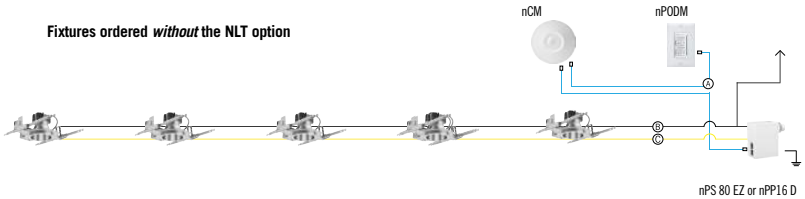
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	rCMS 9 / rCMS PDT 9
Large motion 360°, ceiling	rCMS 10 / rCMS PDT 10

NLIGHT

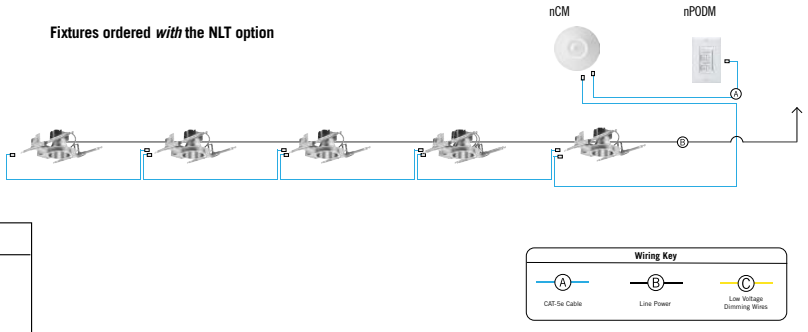
nLight® The nLight® solution is a digital networked lighting control system that provides both energy savings and increased user configurability by cost effectively integrating time-based, daylight-based, sensor-based and manual lighting control schemes.

Possibilites for nLight® wired

Fixtures ordered *without* the NLT option



Fixtures ordered *with* the NLT option



nLight® Wired Control Accessories
Order as separate catalog number. Visit nLight.

Wall Switches	Model Number
On/Off single pole	nPODM (color)
On/Off two pole	nPODM 2P (color)
On/Off & raise/lower single pole	nPOD DX (color)
On/Off & raise/lower two pole	nPODM 2P DX (color)
Graphic touchscreen	nPOD GFX (color)
Photocell Controls	
Dimming	nCM ADCX

nLight® Wired Control Accessories *(cont.)*

Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	nCM 9 / nCM PDT 9
Large motion 360°, ceiling	nCM 10 / nCM PDT 10
Wide View	nWV 16 / nWV PDT 16
Wall switch with raise/lower	nWSX LV DX / nWSX PDT LV DX
Cat-5 Cables (plenum rated)	
10', CAT5	CAT5 10FT J1
15', CAT5	CAT5 15FT J1

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Multiple Layers of Light

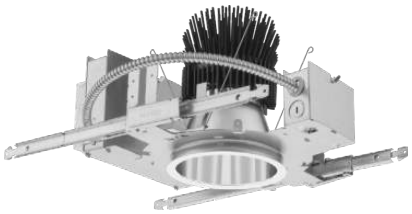
Luminaire Type: L7D

Catalog Number:

Approved Alternate Manufacturers:
Portfolio "LD6A10" Series
Indy "L6" Series
Vantage 6" Downlight

General Illumination Round Downlight 6"

250 - 8,000 lumens



10,000 - 17,500 lumens

OVERVIEW

Feature Set

- Bounding Ray™ optical design
- Unitized optics mechanically attach the light engine to the lower reflector for complete optical alignment.
- 45° cutoff to source and source image
- Fully serviceable and upgradeable lensed LED light engine
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling
- Available with 10% dimming, 1% dimming, or dim to dark
- Batwing distribution with feathered edges provides even illumination on horizontal and vertical surfaces
- ENERGY STAR® certified product

Distribution

very narrow 0.5 S:MH | narrow 0.7 S:MH | medium 0.9 S:MH | medium wide 1.0 S:MH | wide 1.2 S:MH

Superior Performance

Nominal Lumens	250	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000	6000	8000	10,000	12,000	15,000	17,500
Delivered Lumens	297	519	776	994	1471	2006	2537	3077	3542	4027	4533	5256	6371	8247	10637	12332	15776	17801
Wattage	3.4	6.2	8.2	9.6	14.7	19.7	24.7	29.5	33.8	39.0	47.3	48.7	57.6	74.9	97.1	115.0	150.9	175.3
Lumens per Watt	87.4	83.7	94.6	103.5	100.1	101.8	102.7	104.3	104.8	103.3	95.8	107.9	110.6	110.1	109.5	107.2	104.5	101.5

COMPLIMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light

General Illumination Layer | EVO

High Center Beam Layer | Incito

EVO + Incito — Multiple Layers of Light

Core

Downlight | Adjustable | Open Wallwash | Lensed Wallwash | Cylinder | Pinhole | Bevel | Hyperbolic

Healthcare

MRI | Surgical Suite | Patient Room

Special Applications

Dynamic | Food Service | Vandal/Tamper | Clean Room | Shower | Steam Room

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6" General Illumination Round Downlight

ORDERING INFORMATION

A+ Capable options indicated by this color background.

Design2Ship Quick Ship Program: Options in green text qualify for Design2Ship — 5 business days from order entry to ship. Refer to Design2Ship Brochure for complete program details. **Maximum Order Quantity: 100 units; 50 for Chicago Plenum.**

Luminaire Type: L7D

Catalog Number:

EXAMPLE: EV06 35/150 AR MWD LSS MVOLT EZ1

Series	Color Temperature	Nominal Lumen Values	Reflector & Flange Color	Trim Style	Distribution
EV06	27/ 2700 K 30/ 3000 K 35/ 3500 K 40/ 4000 K 50/ 5000 K	02 250 lumens 05 500 lumens 07 750 lumens 10 1000 lumens 15 1500 lumens 20 2000 lumens 25 2500 lumens 30 3000 lumens 35 3500 lumens 40 4000 lumens 45 4500 lumens 50 5000 lumens 60 6000 lumens 80 8000 lumens 100 10000 lumens 120 12000 lumens 150 15000 lumens 175 17500 lumens	AR Clear PR Pewter WTR Wheat GR Gold WR[1] White BR[1] Black WRAMF[1] White Anti-microbial	(blank) Self-flanged FL Flangeless	VND Very Narrow (0.5 s/mh) ND Narrow (0.7 s/mh) MD Medium (0.9 s/mh) MWD Medium Wide (1.0 s/mh) WD Wide (1.2 s/mh)

Finish	Voltage	Driver[4]	
LSS Semi-specular LD Matte-diffuse LS Specular	MVOLT 120 277 347[2,3]	GZ10 0-10V driver dims to 10% GZ1 0-10V driver dims to 1% EZ10 eldoLED 0-10V ECOdrive. Linear dimming to 10% min. EZ1 eldoLED 0-10V ECOdrive. Linear dimming to 1% min. EZB eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%. EDAB[5] eldoLED SOLOdrive DALI. Logarithmic dimming to <1%. EDXB[5] eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Includes termination resistor. Refer to DMXR Manual. Minimum 1000 lumens/Maximum 15000 lumens.	ECOS2[5] Lutron® Hi-Lume® 2-wire forward-phase driver. Minimum dimming level 1%, 120V only. Minimum 1000 lumens/Maximum 4000 lumens. ECOD[5] Lutron Ecosystem digital Hi-Lume 1% soft-on, fade to black. Max: 4000LM.

Provide for EM lights only

Control Interface	Options	
NLT[6] nLight® dimming pack controls NLTER[2,6,9] nLight® dimming pack controls emergency circuit NLTAIR2[13] nLight® AIR enabled NLTAIRER2[2,9,13] nLight® AIR enabled emergency EXA1 XPoint Wireless, eldoLED driver. Linear dimming to 1% EXAB XPoint Wireless, eldoLED driver. Logarithmic dimming to 0.1%	SF Single fuse. Specify 120V or 277V. TRW[7] White painted flange TRBL[8] Black painted flange EL Emergency battery pack, 10W, with integral test switch ELR Emergency battery pack, 10W, with self-diagnostics, with remote test switch ELSD Emergency battery pack, 10W, with self-diagnostics, integral test switch ELRSD Emergency battery pack, 10W, with self-diagnostics, remote test switch E10WCP Emergency battery pack, 10W Constant Power, CA Title 20 compliant with integral test switch E10WCPR Emergency battery pack, 10W Constant Power, CA Title 20 compliant with remote test switch	N80[10] nLight® Lumen Compensation BGTD Bodine generator transfer device. Specify 120V or 277V. 90CRI High CRI (90+) CP[11] Chicago Plenum. Specify 120V or 277V for 5000lm and above. HAO[12] HAO High Ambient Option (40°C) RRL_ RELOC®-ready luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Refer to RRL for complete nomenclature

ACCESSORIES – order as separate catalog numbers (shipped separately)

SCA6	Sloped ceiling adapter. Degree of slope must be specified (5D, 10D, 15D, 20D, 25D, 30D). Ex: SCA6 10D. Refer to TECH-190.
CTA4-8 YKHL	Ceiling thickness adapter for 10,000LM and above (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
CTA4-8 YK	Ceiling thickness adapter for 8,000LM and below (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
GVRT	Vandal-resistant trim accessory. Refer to TECH-200.
ISD BC	0-10V wallbox dimmer. Refer to ISD-BC.

ORDERING NOTES

1. Not available with finishes.
2. Not available with emergency battery pack options.
3. Supplied with factory installed step down transformer.
4. Refer to TECH-240 for compatible dimmers.
5. Not available with nLight® and XPoint options.
6. Specify voltage.
7. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with WR (white reflector) or FL (flangeless) option.
8. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with BR (black reflector) or FL (flangeless) option.
9. ER for use with generator supply power. Will require an emergency hot feed and normal hot feed.
10. Fixture begins at 80% light level. Must be specified with NLT or NLTER. Only available with EZ10 and EZ1 drivers.
11. 12,000LM max with EL or nLight® options. 5,000LM max with Lutron drivers combined with EL. Not available with ELR, HAO, EXA1, or EXAB options.
12. Only available 5000LM - 15,000LM with eldoLED drivers.
13. Not available DALI or DMX drivers. Not available with CP or N80 options. Not recommended for metal ceiling installations.

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SPECIFICATIONS

Optical Assembly

Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.

Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top-down flash characteristic for superior glare control.

Unitized optics shall have mechanical attachment of the light engine to the lower reflector for complete optical alignment.

Electrical

The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.

The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages.

Input wires shall be 18AWG, 300V minimum, solid copper.

Controls

Luminaire shall be equipped with interface for nLight wired or wireless network with integral power supply as per specification.

Dimming

The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 10%, 100 – 1.0% or 100 – 0.1% of rated lumen output with a smooth shut off function to step to 0%.

eldoLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered.

Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction

Luminaire housing shall be constructed of 16-gauge galvanized steel and have preinstalled telescopic mounting bars with maximum 32" and minimum 15" extension and 4" vertical adjustment.

Luminaires shall be suitable for installation in ceilings up to 1½" thick. (specify ceiling thickness adapter to extend frame to accommodate ceiling thickness up to 5").

Tool-less adjustments shall be possible after installation.

The assembly and manufacturing process for the luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.

25°C ambient temperature standard (1/2" clearance on all sides from non-combustible materials in non-IC applications, unless marked spacing noted otherwise). For use in insulated ceilings, a 3" clearance on all sides from insulation is required (unless marked spacing noted otherwise). 40°C high ambient optional.

Listings

Fixtures are CSA certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, wet location covered ceiling. Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.

Photometrics

LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.

Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by a point at the intersection of the CCT line and the black body locus line in CIE chromaticity space.

Warranty

5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note:

Actual performance may differ as a result of end user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

Marked Spacing in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
500-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000			9
12000			
15000			
17500	72	36	

Marked Spacing in Inches 40°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
5000	24	12	5
6000			
8000	48	24	9
10000			
12000			
15000	72	36	9

Marked Spacing Chicago Plenum Open Frame in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
250-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000			9
12000			
15000			
17500	72	36	

Marked Spacing Chicago Plenum Enclosure in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
250-6000	None	None	None
8000	36	18	6
10000	48	24	3
12000			

EVO - eldoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EXA1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic	Linear
EXAB	<1%	Logarithmic	Linear
EDXB	<1%	Square	Linear

Lumen Output Multiplier		
CRI	CCT	Multplier
80	2700K	0.96
	300K	1.00
	3500K	1.00
	4000K	1.01
	5000K	1.07
90	2700K	0.80
	300K	0.83
	3500K	0.85
	4000K	0.87
	5000K	0.91

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73

Distributions		
Nomenclature	Beam Angle	Field Angle
VND	30	64
ND	44	69
MD	54	82
MWD	67	89
WD	71	92

Driver		Control Provided (note: 347V/UVOLT versions provided with 347 option selected)			
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIRER2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ10	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ1	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZB	eldoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2

How to Estimate Delivered Lumens in Emergency Mode

Delivered Lumens = 1.25 x P x LPW

P = Output power of emergency driver. P = 10W for PS1055CP

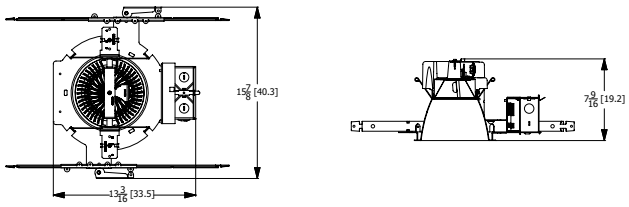
LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.

DIMENSIONAL DATA

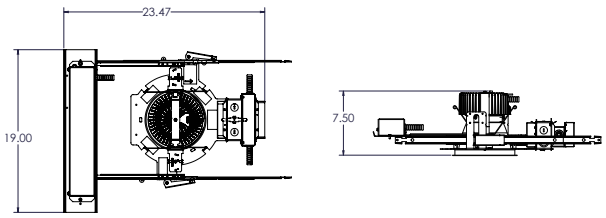
*Dimensions in inches [centimeters]

Aperture: 6 1/4" [15.9)]	Ceiling Opening: 7 1/8" [18.1] self-flanged
Overlap Trim: 7 1/2" [19.1]	7 1/4" [18.4] flangeless

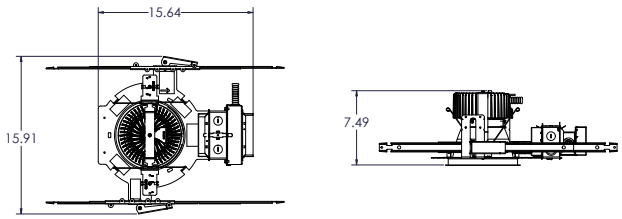
1000LM-4500LM Standard



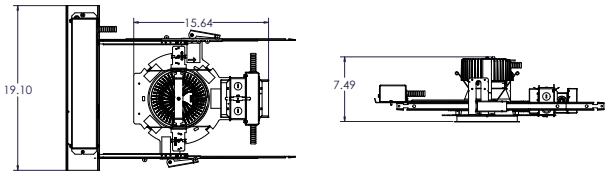
1000LM-4500LM Battery Pack



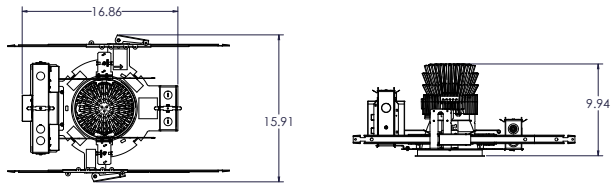
5000LM-8000LM Standard



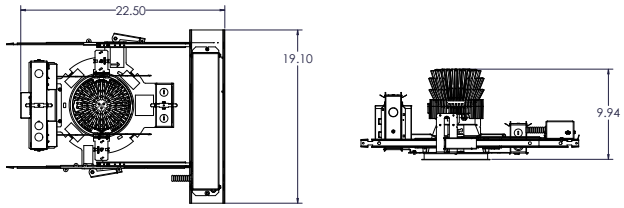
5000LM-8000LM Battery Pack



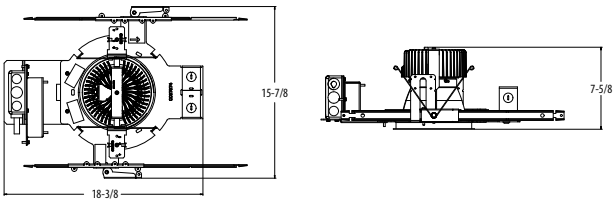
10,000LM-17,500LM Standard



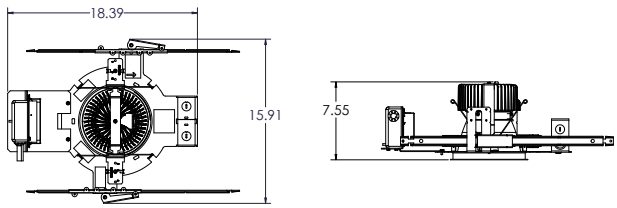
10,000LM-17,500LM Battery Pack



1000LM-4500LM CP



5000 Lumen ECO/SOLO Drive Open Frame CP



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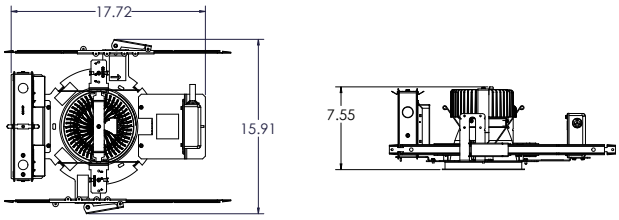
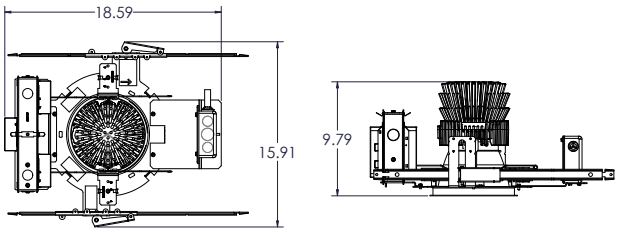
DIMENSIONAL DATA

*Dimensions in inches [centimeters]

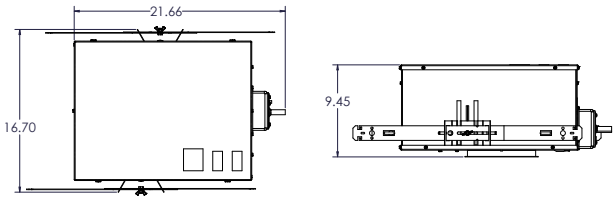
5000 (Lutron & POWER Drive Only), 6000 & 8000 Lumen Open Frame CP



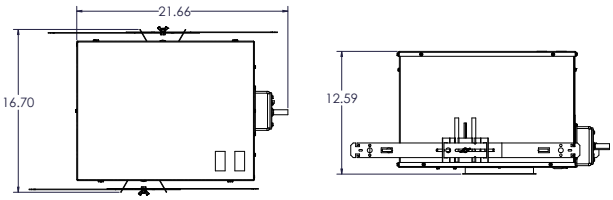
10000 - 17,500 Lumen Open Frame CP



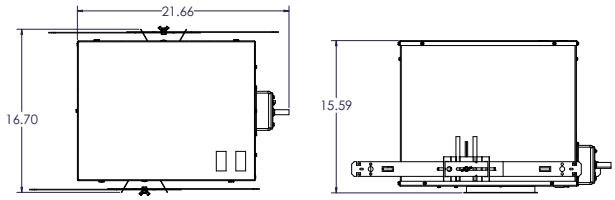
250 - 6000 Lumen CP for nLight® or Battery Pack



8,000LM Enclosed CP for nLight or Battery Pack



10,000LM-12,000LM Enclosed CP for nLight or Battery Pack



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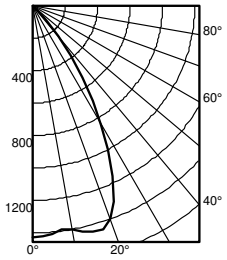
EV06 35/15 AR MWD LS INPUT WATTS: 14.7, DELIVERED LUMENS: 1471LM, LPW= 100, 1.03 S/MH, TEST NO. LTL27783P1505



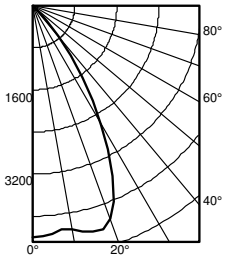
	Ave	Lumens
0	1431	
5	1410	134
15	1442	405
25	1161	523
35	540	332
45	78	72
55	3	4
65	1	1
75	0	1
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	1061.4	72.2
0° - 40°	1393.5	94.7
0° - 60°	1469.5	99.9
0° - 90°	1470.9	100.0
90° - 180°	0.0	0.0
0° - 180°	1470.9	*100.0
	*Efficiency	

pf	20%								
pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	105	103	101
2	103	99	96	101	98	95	98	95	93
3	96	91	87	95	90	87	92	88	85
4	90	84	80	89	84	80	87	82	79
5	84	78	74	83	78	74	81	77	73
6	79	73	69	78	73	69	77	72	68
7	74	68	64	74	68	64	72	67	63
8	70	64	60	69	64	60	68	63	59
9	66	60	56	65	60	56	64	59	56
10	62	56	52	62	56	52	61	56	52

		50% beam - 54.4°		10% beam - 77.9°	
Mounting Height	Inital FC Center Beam	Diameter	FC	Diameter	FC
8.0	47.3	5.7	23.7	8.9	4.7
10.0	25.4	7.7	12.7	12.1	2.5
12.0	15.9	9.8	7.9	15.3	1.6
14.0	10.8	11.8	5.4	18.6	1.1
16.0	7.9	13.9	3.9	21.8	0.8

EV06 35/45 AR MWD LS INPUT WATTS: 47.3, DELIVERED LUMENS: 4532.7LM, LPW= 95.8, 1.03 S/MH, TEST NO. LTL27783P1649



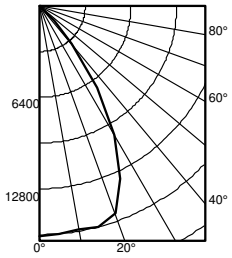
	Ave	Lumens
0	4411	
5	4346	413
15	4443	1247
25	3578	1610
35	1665	1024
45	242	222
55	8	12
65	2	3
75	1	2
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	3270.7	72.2
0° - 40°	4294.2	94.7
0° - 60°	4528.3	99.9
0° - 90°	4532.7	100.0
90° - 180°	0.0	0.0
0° - 180°	4532.7	*100.0
	*Efficiency	

pf	20%								
pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	105	103	101
2	103	99	96	101	98	95	98	95	93
3	96	91	87	95	90	87	92	88	85
4	90	84	80	89	84	80	87	82	79
5	84	78	74	83	78	74	81	77	73
6	79	73	69	78	73	69	77	72	68
7	74	68	64	74	68	64	72	67	63
8	70	64	60	69	64	60	68	63	59
9	66	60	56	65	60	56	64	59	56
10	62	56	52	62	56	52	61	56	52

		50% beam - 54.4°		10% beam - 77.9°	
Mounting Height	Inital FC Center Beam	Diameter	FC	Diameter	FC
8.0	145.8	5.7	72.9	8.9	14.6
10.0	78.4	7.7	39.2	12.1	7.8
12.0	48.9	9.8	24.4	15.3	4.9
14.0	33.4	11.8	16.7	18.6	3.3
16.0	24.2	13.9	12.1	21.8	2.4

EV06 35/175 AR MWD LS INPUT WATTS: 175.3, DELIVERED LUMENS: 17801LM, LPW=101.5, 1.06 S/MH, TEST NO. ISF 34035P268



	Ave	Lumens
0	16146	
5	15998	1521
15	16006	4479
25	13362	6001
35	7018	4289
45	1470	1299
55	100	156
65	37	38
75	13	14
85	2	2
90	0	

Zone	Lumens	% Lamp
0° - 30°	12002.3	67.4
0° - 40°	16291.0	91.5
0° - 60°	17746.3	99.7
0° - 90°	17801.0	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	17801.0	*100.0
	*Efficiency	

pf	20%								
pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	108	106	104	104	103	101
2	103	98	95	101	97	94	98	95	92
3	95	90	86	94	89	86	91	87	84
4	89	83	79	88	82	78	85	81	77
5	83	77	72	82	76	72	80	75	71
6	77	71	67	77	71	67	75	70	66
7	73	66	62	72	66	62	71	65	61
8	68	62	58	67	62	57	66	61	57
9	64	58	54	63	58	54	62	57	53
10	60	54	50	60	54	50	59	54	50

		50% beam - 55.7°		10% beam - 79.8°	
Mounting Height	Inital FC Center Beam	Diameter	FC	Diameter	FC
8.0	533.7	5.8	266.9	9.2	53.4
10.0	287.0	7.9	143.5	12.5	28.7
12.0	178.9	10.0	89.4	15.9	17.9
14.0	122.1	12.1	61.0	19.2	12.2
16.0	88.6	14.3	44.3	22.6	8.9

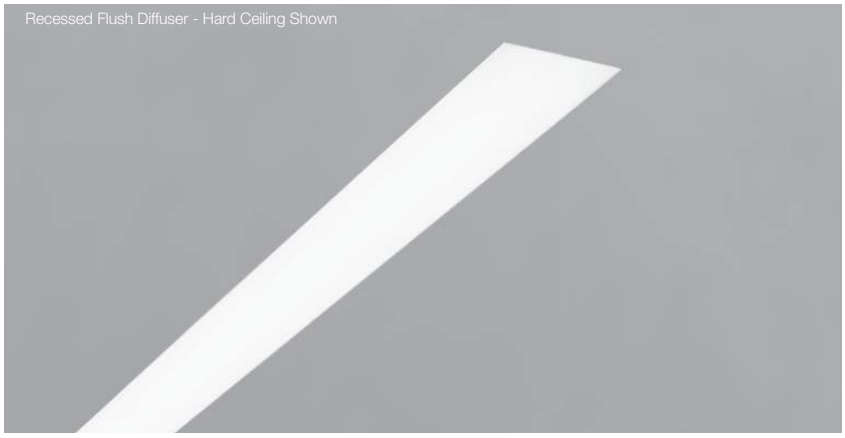
Submitted by:	Date:
Type:	Project:
Ordering Info:	

BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8

LIGHT FIXTURE REQUIRED TO BE DLC LISTED



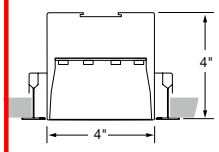
High Performance 4" Aperture is a patented, linear LED luminaire family. HP-4 delivers excellent performance using an advanced optical design and mid-power LEDs. Achieving 90% of initial light output at 100,000+ hours and backed by a 10-year performance-based warranty on all standard components.

This product is enrolled in the International Living Future Institute (ILFI) Declare 2.0 Program and is third-party verified with options achieving Red List Approved and Declared status.

Note: see page 6 for all aesthetic options

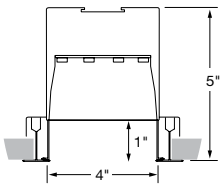
CROSS SECTIONS

Recessed



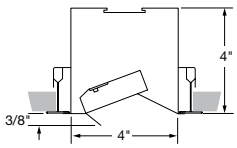
Flush Downlight Diffuser (standard)

Regressed



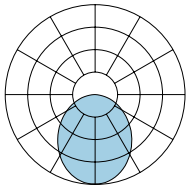
Flat Diffuser with 1" Regressed

Wall Wash Recessed

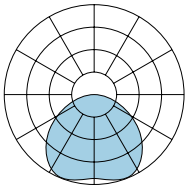


Kicker (standard)

OPTIC OPTIONS



Standard Downlight Optic (**F**)



Downlight Spread Optic (**DSO**)

ALSO AVAILABLE IN

Pendant (**D, ID, I**)

Wall Mount (**WM**)

Surface Mount (**SM**)

Fine TUNE Option Available

Protected by one or more US Patents: 8915613; D702,391; D702,390; D700,732

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

L8

BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed

Clear Form

BODY TYPE

Platform	Series Name	Luminaire Type	Luminaire Distribution	Total Length of Run
◉ **HP** - High Performance	◉ **4**	◯ **R** - Recessed ◯ **R RG** - Recessed Regressed (Wall Wash not available)	◯ **D** - Direct ◯ **WW-D** - Wall Wash Direct	_____ Minimum 2' section length. Increments accurate to 1/16" (±1/32"), standard. 12' maximum section length.

SEE LIGHTING PLAN FOR LENGTHS

OUTPUT and LED TYPE

Downlight Output	LED CRI/CCT
◯ **S** - Standard ◯ **B** - Boosted Standard ◯ **H** - High ◯ **V** - Very High ◯ **TL** - Tailored: _____ lm/ft* * Specify lm/ft of outputs between Standard (S) and Very High (V). Consult factory for tailored lumen output outside of this range.	◯ **830** - 80 CRI, 3000K ◯ **835** - 80 CRI, 3500K ◯ **840** - 80 CRI, 4000K ◯ **930** - 90 CRI, 3000K ◯ **935** - 90 CRI, 3500K ◯ **940** - 90 CRI, 4000K ◯ **8TW** - 80 CRI, Tunable White ◯ **9TW** - 90 CRI, Tunable White

MECHANICAL/OPTICAL OPTIONS

Downlight	Reflector System
◯ **F** - Flush (standard) ◯ **DL** - 1" Drop Down Lens ◯ **RG-D** - Flat Diffuser with 1" Regress [1] ◯ **RG-WCB** - White Cross Blade Baffle [1] ◯ **RG-LHE** - Hollowed Ellipse Louver [1] ◯ **RG-LHC** - Hex Louver [1] ◯ **DSO** - Downlight Spread Optic [2] ◯ **K** - Kicker for Wall Wash only ◯ **FO** - Fully Open for Wall Wash only	◯ **96LG** - 96 Low Gloss White ◯ **SSA** - Semi-Specular Aluminum for Wall Wash only

ELECTRICAL OPTIONS

Voltage	Circuiting [3]
◯ **120** - 120 Voltage ◯ **277** - 277 Voltage ◯ **347** - 347 Voltage	◉ **SC** - Single Circuit* * Battery, Night Light, and Emergency to Generator circuits are in addition to the normal luminaire circuit(s)

ELECTRICAL OPTIONS

Driver Selection

0-10V Driver Options
- ◯ **FC-10%** - 0-10V 10% [4] (standard)
- ◯ **FC-1%** - 0-10V 1% [4]
- ◯ **OSR-10%** - Osram OTi, 0-10V 10% [4]
- ◯ **OSR-1%** - Osram OTi, 0-10V 1% [4]
- ◯ **ELD-10V-0%** - EldoLED SOLOdrive, 0-10V 0.1%
- ◯ **OSR-10V-TW** - Osram OTi, 0-10V 10% *(Tunable White)* [4]

DALI Driver Options
- ◯ **FC-DALI-1%** - DALI 1%
- ◯ **OSR-DALI-1%** - Osram Dexal, 1%
- ◯ **ELD-DALI-0%** - EldoLED SOLOdrive, 0.1%
- ◯ **ELD-DALI-TW** - EldoLED DUALdrive LightShape, 0.1% *(Tunable White)*

DMX Driver Options
- ◯ **FIN-DMX** - Finelite DMX 1% *(Tunable White - FineTune Controls Only)* [5]
- ◯ **ELD-DMX** - EldoLED POWERdrive, 0.1%
- ◯ **ELD-DMX-TW** - EldoLED POWERdrive, 0.1% *(Tunable White)*

Lutron Driver Options
- ◯ **LUT-ES1** - Lutron, Ecosystem 1%
- ◯ **LUT-ES5** - Lutron, Ecosystem 5%
- ◯ **LUT-2W** - Lutron, 2-wire (120V only) 1%
- ◯ **LUT-TW** - Lutron T-Series, EcoSystem 0.1% *(Tunable White)*

See Page 3 for additional driver options and details

MOUNTING OPTIONS

Ceiling Hardware Type

- ◯ **C1** - 1" T-Bar
- ◯ **C1T** - 1" Tegular
- ◯ **C2** - 9/16" T-Bar
- ◯ **C2T** - 9/16" Tegular
- ◯ **C3** - Screw Slot
- ◯ **C3F** - Flush Screw Slot
- ◯ **SF** - Spackle Flange
- ◯ **VF** - Visible Flange
- ◯ **TZ6** - Tech Zone 6" _____ (C1, C2, C2T, C3, C3F)

OTHER OPTIONS

Endcap Style	Finish	Emergency Style (Optional)	Integrated Sensor (Optional)	Special Options (Optional)
◉ **FE** - Flat Endcap (standard)	◯ **SW** - Signal White (standard) ◯ **FB** - Finelite Black [6] ◯ **SA** - Satin Aluminum [6] ◯ **####** - RAL Color Code [6] _____	◯ **FAC CHO** - Factory Choice Battery Back-up ◯ **EM/GEN** - Emergency to Generator ◯ **NL** - Night Light ◯ **BSL722** - Bodine Battery Back up ◯ **BSL310LP** - Bodine Battery Back up Low Profile ◯ **GTD** - Generator Transfer Device	◯ **OBO** - Occupancy [7] ◯ **OBD** - Daylight [7] ◯ **OBE** - Enlighted [8] ◯ **REE** - Remote Enlighted [9]	◯ **CP** - Chicago Plenum ◯ **FLX** - Flex Whip ◯ **RLA** - Red List Approved ◯ **RLD** - Declared

AS INDICATED ON PLAN

[1] Recessed Regressed only
[2] Not available with Regressed or Curves
[3] Contact factory for switching options
[4] Add DTO to gain "Dim to Off" functionality (FC-10% - DTO)
[5] B & V outputs only
[6] 20 business days lead time for color
[7] Not available with Wall Wash
[8] Enlighted components installed by Finelite, provided by others
[9] Enlighted for Wall Wash fixtures. Enlighted Control Unit & Sensor Cable installed for Remote mounting sensor.

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

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FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8

SUPPLEMENTARY DRIVER PAGE

0-10V Driver Options	
FC-10%	Factory Choice, 0-10V 10% Dimming (Linear)
FC-10%-DTO	Factory Choice, 0-10V 10% Dimming, Dim-to-Off (Linear)
FC-1%	Factory Choice, 0-10V 1% Dimming (Linear)
FC-1%-DTO	Factory Choice, 0-10V 1% Dimming, Dim-to-Off (Linear)
ELD-10V-0%	EldoLED SOLOdrive, 0-10V 0.1% Dimming (Linear)
ELD-10V-1%	EldoLED ECOdrive, 0-10V 1% Dimming (Linear)
OSR-10V-TW	Osram OTi, 0-10V 10% Dimming, *Tunable White* (Linear)
OSR-10V-TW-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off, *Tunable White* (Linear)
OSR-10%	Osram OTi, 0-10V 10% Dimming (Linear)
OSR-10%-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off (Linear)
OSR-1%	Osram OTi, 0-10V 1% Dimming (Linear)
OSR-1%-DTO	Osram OTi, 0-10V 1% Dimming, Dim-to-Off (Linear)

DALI Driver Options	
FC-DALI-1%	Factory Choice, DALI 1% Dimming (Logarithmic)
OSR-DALI-1%	Osram Dexal, DALI 1% Dimming (Logarithmic)
ELD-DALI-0%	EldoLED SOLOdrive, DALI 0.1% Dimming (Logarithmic)
ELD-DALI-1%	EldoLED ECOdrive, DALI 1% Dimming (Logarithmic)
ELD-DALI-TW	EldoLED DUALdrive Light Shape, DALI 0.1% Dimming, *Tunable White* (Logarithmic Dimming, Linear CCT Control)

DMX Driver Options	
FIN-DMX	Finelite, DMX 1% Dimming, *Tunable White* - **FineTUNE Controls Only** (Linear)
ELD-DMX	EldoLED POWERdrive, DMX 0.1% Dimming (8 Bit, 1CH) (Linear)
ELD-DMX-16	EldoLED POWERdrive, DMX 0.1% Dimming (16 Bit, 2CH) (Linear)
ELD-DMX-TW	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (8 Bit, 2CH - CH1 Warm / CH2 Cool) (Linear)
ELD-DMX-TW16	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (16 Bit, 4CH - CH1, 2 Warm / CH3, 4 Cool) (Linear)

Lutron Driver Options	
LUT-ES1	Lutron, Ecosystem 1% Dimming
LUT-ES5	Lutron, Ecosystem 5% Dimming
LUT-2W	Lutron, 2-wire (120V only) 1% Dimming
LUT-TW	Lutron T-Series, EcoSystem 0.1% Dimming, *Tunable White*

Submitted by:	Date:
Type:	Project:
Ordering Info:	

BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8

SPECIFICATIONS

BODY TYPE

CONSTRUCTION: Precision-cut 6061-T6 extruded aluminum body. Internal joiner system, plug-together wiring, standard.

LENGTHS: Any length, 2' minimum, in increments down to 1/16" (±1/32"). 12' maximum section length. Hollowed Ellipse Louver (**LHE**), Hex Louver (**LHC**), and White Cross Blade Baffle (**WCB**) are available in 1' increments.

MITERED CORNERS [1]: Illuminated corners of greater than 60° and less than 180° in a single plane, available with Flush Diffuser, Bottom Glow Diffuser, 1" Drop Down Lens, Regressed Diffuser, White Cross Blade Baffle[2] or Wall Wash. Corners not available with Wall Wash (**WW-D**), Hollowed Ellipse Louver (**LHE**) or Hex Louver (**LHC**). Consult factory for tailored lighting options.

OUTPUT AND LED TYPE

LIGHT OUTPUT: Four lumen packages available, Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). For lengths 3' and greater, the uplight and downlight can be specified with different lumen packages and dual controls. For Tailored Outputs outside of range from Standard (**S**) to Very High (**V**), consult factory. Light engines are replaceable.

MECHANICAL/OPTICAL OPTIONS

DOWNLIGHT OPTION : 12' maximum diffuser length. Flush frost white snap-in diffuser standard, 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination. Available with Flush (**F**), 1" Drop Down Lens (**DL**), White Cross Blade Baffle (**WCB**) [3, 4], Ellipse Louver (**LHE**) [3], Hex Louver (**LHC**) [3], Downlight Spread Optic (**DSO**), and Regressed downlight diffusers (**RG**) [3]. 1" Drop Down Lens made of acrylic. Available with a solid endcap or an endcap with a diffuse filler to continue the luminous aesthetic. Downlight Spread Optic is an extruded lens with a subtle ribbed appearance providing a batwing distribution for improved optical performance. Consult factory for more tailored lumen outputs.

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

REFLECTORS: Die-formed 20-gauge cold-rolled steel reflectors finished in 96LG High Reflectance white powder coat paint. The standard Semi-Specular Aluminum (**SSA**) Kicker (**K**) reflector delivers light high on the vertical surface. The Kicker reflector can be easily removed for open distribution (**FO**).

ELECTRICAL OPTIONS

STATIC WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed wire controlling uplight and downlight together (power and dimming). Specify dual feed wires for independent control of uplight and downlight. 14-gauge feed wire used when luminaire current exceeds 5 amps.

TUNABLE WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when luminaire current exceeds 5 amps. DMX and power feed at same location (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths.

STATIC WHITE DRIVER: Replaceable 120V, 277V, and 347V constant current reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 10%- 100% standard. Dimming to 1% available. Separate dimming for uplight and downlight available. Driver is fully accessible from below the ceiling.
- **Power Factor:** ≥ 0.9
- **Total Harmonic Distortion (THD):** <20%
- **Expected driver lifetime:** 100,000 hours

LUTRON DRIVER OPTIONS:
- **LUTES1** (Hi-lume 1% EcoSystem with Soft-On, Fade-to-Black dimming (LDE1 series))
- **LUTES5** (5-Series 5% EcoSystem (LDE5 Series))
- **LUT2W** (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)).

TUNABLE WHITE DRIVER: Replaceable LED driver. Driver is accessible from below the ceiling. 120V, 277V, and 347V.
- **Power factor:** ≥0.90
- **Total Harmonic Distortion (THD):** <20%
- **Dimming Range:** 100%-10%
- **Expected driver lifetime:** 100,000 hours
- FineTune DMX is 1%

LUTRON TUNABLE WHITE DRIVER OPTION:
LUT-TW (0.1% T-Series 2-Channel Digital Tunable White (PSQ Series)).

MOUNTING OPTIONS

HANGING HARDWARE:
- **Recessed T-Bar:** Standard bracket design works with most lay-in ceiling types. Brackets secure luminaire to the ceiling grid from above. Tie-in T-Bar brackets connect the luminaire to the T-Bar for securing to structure. Consult local codes for tie-wire recommendations.
- **Recessed Spackle Flange:** Drywall surfaces (walls or ceilings): 1/4" - 20 stud and nut (provided by others). Mounted with three equidistant suspension points.

[1] Not available with Wall Wash
[2] White Cross Blade (WCB) baffles not available with custom angles. Available in 90 degrees only
[3] Recessed-Regressed only
[4] White Cross Blade Baffle (WCB) currently not advisable for drywall

Continued

Submitted by:	Date:
Type:	Project:
Ordering Info:	

BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8

SPECIFICATIONS

TUNABLE WHITE DMX HANGING HARDWARE: For grid ceiling applications the dual GridBox™ mounting is supplied (standard). For hard ceiling applications the ceiling mounting box is supplied (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths. Available DMX pendant feed lengths are 5' (standard), 12', and 30'.

TUNABLE WHITE DMX INTERCONNECTION CABLES: Luminaires are pre-wired with plug-and-play interconnection cables to support easy plug-together joining of fixture runs. If a non-FineTune DMX system has been specified, a DMX to RJ45 converter is provided.

OTHER OPTIONS

ENDCAPS: Flat endcaps (**FE**) at each end of run add 1/16" to each end of luminaire. Drop Down Lens Illuminated Endcap (**DE**) includes diffuse element to continue luminance of drop lens.

EMERGENCY STYLE: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, step-dimming driver, backup battery.

Backup Battery			
	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-R-D			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'
HP4-R-WW-D			
Min. Housing Length	8'*	4'*	4'*
EM Lumen Output	2000	1189	2000
EM Section Illum.	4'	4'	4'

* Minimum fixture housing length for battery pack approved without sensor

TUNABLE WHITE ELECTRICAL OPTIONS[5]:
- **TW Driver Options 0-10V:** EM/GEN, GTD or Battery Back up
- **FineTune DMX:** EM/GEN or Battery Back up
- **DMX:** Battery Back up
- **DALI:** EM/GEN, GTD or Battery Back up
- **LUTRON:** EM/GEN, GTD or Battery Back up

INTEGRATED SENSORS: Integrated PIR (Passive Infrared) occupancy or daylight sensors available with Flush and Bottom Glow downlight diffusers. Refer to Occupancy Sensor, Daylight Sensor, and Enlighted Sensor tech sheets for more info.

FINISHES: Finelite Signal White (**SW**) powder coat, Finelite Black (RAL 9005) with semi gloss fine texture (**FB**)[6], and Satin Aluminum (**SA**)[6] are standard. Optional Adder: 185 RAL colors[6] are available.

LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.130 (G), this luminaire contains an internal driver disconnect. UL 924 and UL 2108 - PoE options available on request.These fixtures are rated for Damp Location. IC Rated. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2015/863. Consult factory for tailored lighting options. Finelite makes the specification process easy when putting healthier products on your projects. Simply add – **RLA** (Red List Approved) or – **RLD** (Declared Label) to your part number.

WEIGHT[7]: R - 2.8 lb/ft; WW-R - 2.9 lb/ft

DLC QUALIFIED: Configurations of this product are listed on the DLC Qualified Products List (QPL). www.designlights.org/search

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

[5] Consult Finelite for Generator Transfer Device and Battery Backup fit
[6] 20 business days lead time for color
[7] Excludes Battery Backup and Generator Transfer Device weight

Submitted by:	Date:
Type:	Project:
Ordering Info:	

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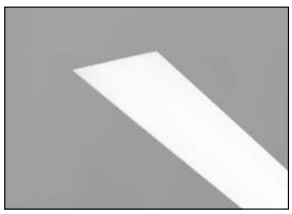
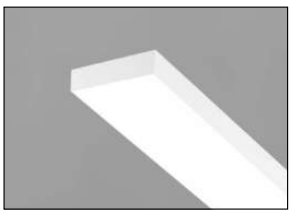
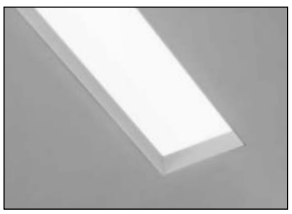
FINELITE®
Better Lighting

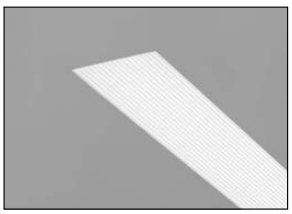
High Performance 4" Aperture (HP-4) Recessed L8

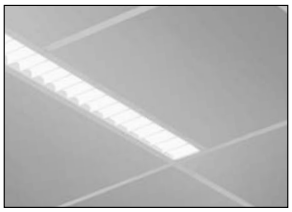
AESTHETIC OPTIONS

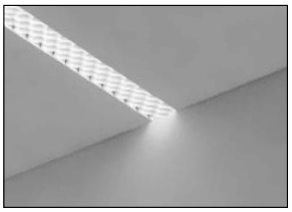

Flush Diffuser (**F**)

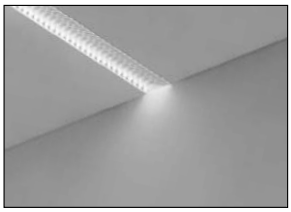

1" Drop Down Lens (**DL**)

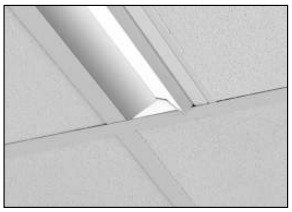

Flat Diffuser with 1" Regressed (**RG-D**)


Downlight Spread Optic (**DSO**)
Externally flush


White Cross Blade Baffle[1] (**RG-WCB**)


Hex Louver[1] (**RG-LHC**)


Hollowed Ellipse Louver[1] (**RG-LHE**)


Kicker (**K**) - Wall Wash only

[1] Regressed only

Submitted by:	Date:
Type:	Project:
Ordering Info:	

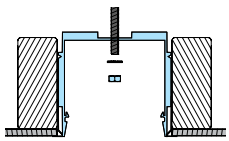
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

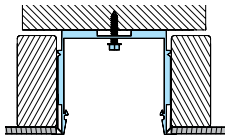
High Performance 4" Aperture (HP-4) Recessed L8

HARD CEILING MOUNTING OPTIONS

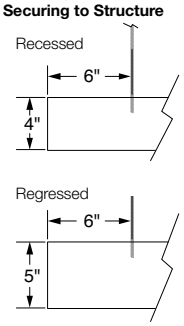
Threaded Rod Option



Screw Mount Option

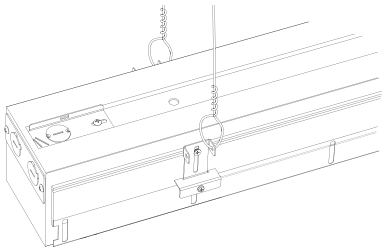


Mounting Location for Securing to Structure



Two mounting options: threaded rod and screw mounting options. Mounting locations are located on each end of the luminaire. Mounting location is 6" away from each end of luminaire.

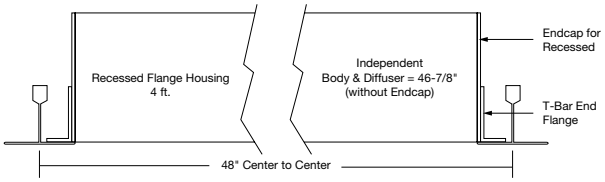
T-BAR INSTALLATION



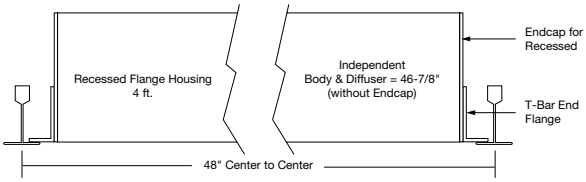
HP-4 R for T-Bar installations comes standard with a splice plate at the end of the luminaire. Mounting brackets (supplied) secure the luminaire to T-Bar and provide support to structure location. All even foot length (2, 4, 6, ...) luminaire runs are reduced in length by an appropriate amount to fit within typical 2x2 and 2x4 T-Bar grid systems. For uncommon T-Bar systems please consult factory.

GRID LENGTH DETAIL - 4' EXAMPLE

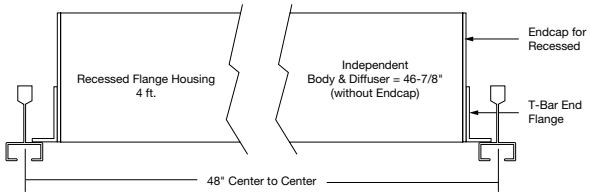
1" T-Bar



9/16" T-Bar

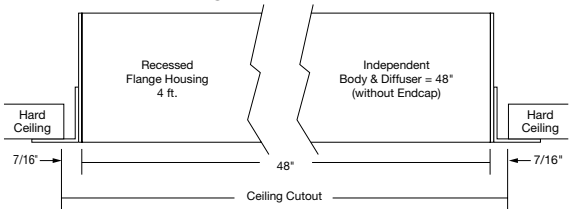


9/16" Screw Slot

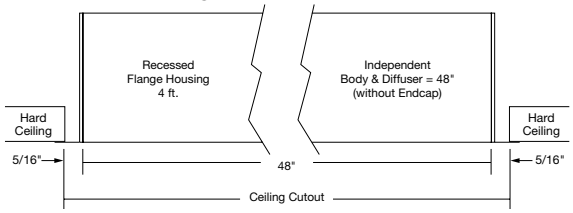


HARD CEILING LENGTH DETAIL - 4' EXAMPLE

Spackle Flange



Visible Flange



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Type:	Project:	
Ordering Info:		

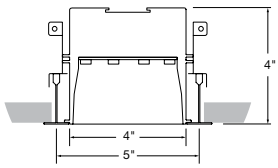
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

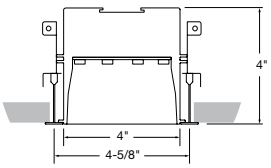
High Performance 4" Aperture (HP-4) Recessed L8

RECESSED MOUNTING TYPES - T-BAR

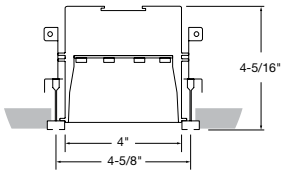
Rough-In Dimensions



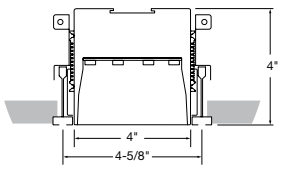
1" T-Bar (C1)



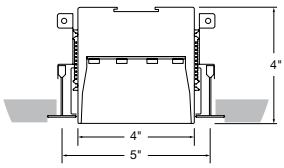
9/16" T-Bar (C2)



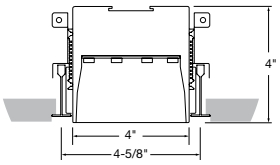
Standard Screw Slot (C3)



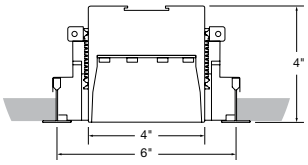
Flush Screw Slot (C3F)



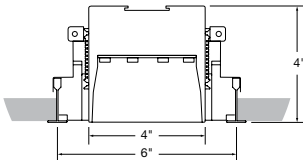
1" Tegular (C1T)



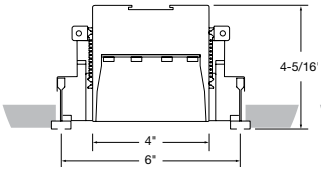
9/16" Tegular (C2T)



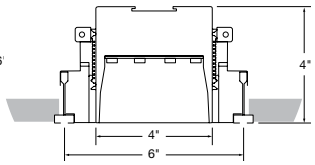
Tech Zone 6" (TZ6)
1" T-Bar (C1)



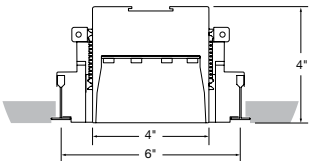
Tech Zone 6" (TZ6)
9/16" T-Bar (C2)



Tech Zone 6" (TZ6)
Standard Screw Slot (C3)

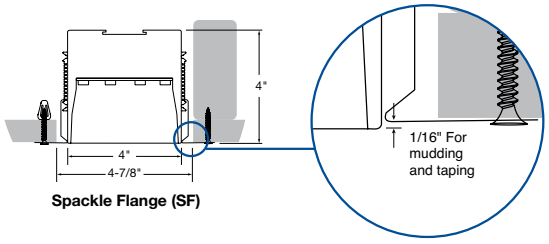


Tech Zone 6" (TZ6)
Flush Screw Slot (C3F)

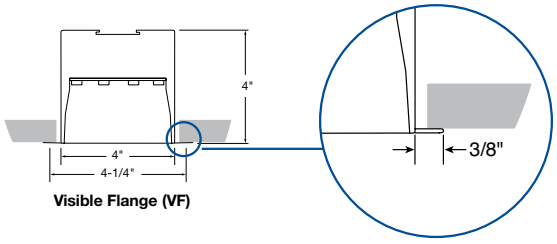


Tech Zone 6" (TZ6)
9/16" Tegular (C2T)

RECESSED MOUNTING TYPES - CUTOUT DIMENSIONS



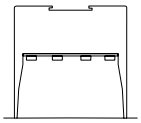
Spackle Flange (SF)



Visible Flange (VF)

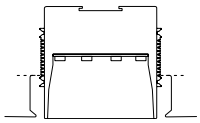
HOUSING

Version 1



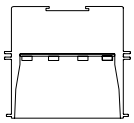
Ceiling Option VF

Version 2



Ceiling Options
C1T, C2T, C3F, SF, TZ6

Version 3



Ceiling Options
C1, C2, C3

Note: +/- 1/16"

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

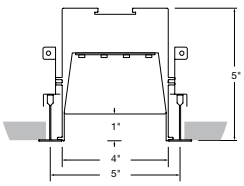
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE®
Better Lighting

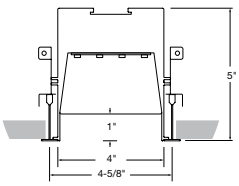
High Performance 4" Aperture (HP-4) Recessed L8

REGRESSED MOUNTING TYPES - T-BAR

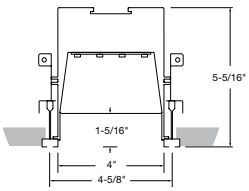
Rough-In Dimensions



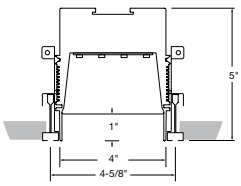
1" T-Bar (C1)



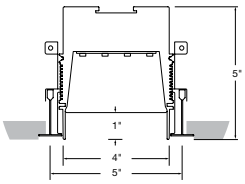
9/16" T-Bar (C2)



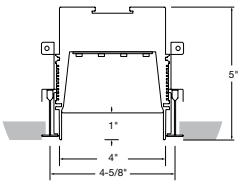
Standard Screw Slot (C3)



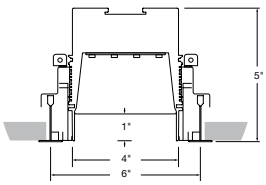
Flush Screw Slot (C3F)



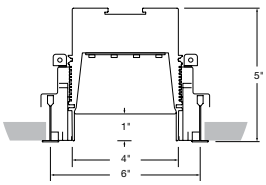
1" Tegular (C1T)



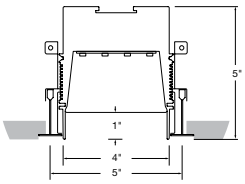
9/16" Tegular (C2T)



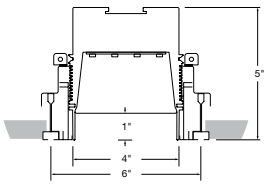
Tech Zone 6" (TZ6)
1" T-Bar (C1)



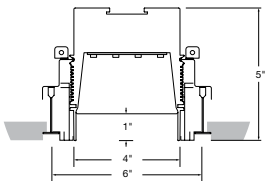
Tech Zone 6" (TZ6)
9/16" T-Bar (C2)



Tech Zone 6" (TZ6)
Standard Screw Slot (C3)

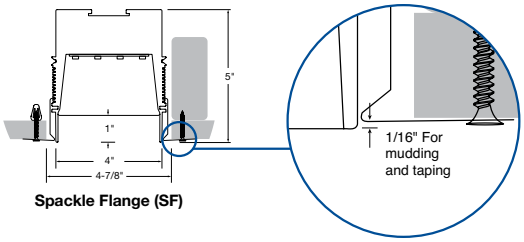


Tech Zone 6" (TZ6)
Flush Screw Slot (C3F)

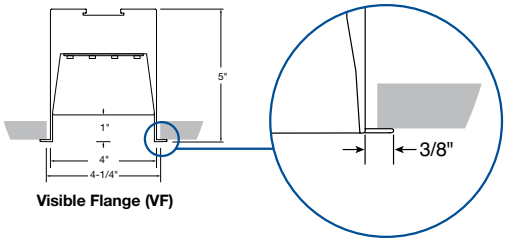


Tech Zone 6" (TZ6)
9/16" Tegular (C2T)

REGRESSED MOUNTING TYPES - CUTOUT DIMENSIONS



Spackle Flange (SF)

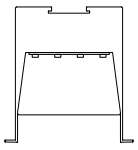


Visible Flange (VF)

Regressed Lens: Regressed lens version is 5" tall with a lens that is regressed 1" from ceiling line.

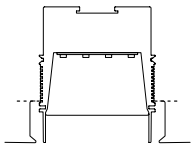
HOUSING

Version 1



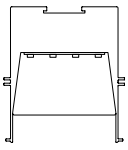
Ceiling Option VF

Version 2



Ceiling Options
C1T, C2T, C3F, SF, TZ6

Version 3



Ceiling Options
C1, C2, C3

Note: +/- 1/16"

Submitted by:	Date:
Type:	Project:
Ordering Info:	

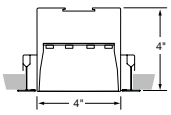
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

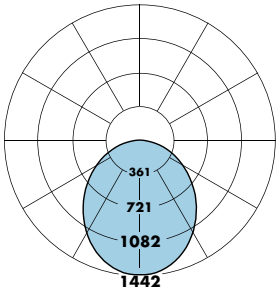
High Performance 4" Aperture (HP-4) Recessed L8

Recessed Photometry - 4' Luminaire 3500K

HP4-R-D-4'-V-835
Downlight: Flush Diffuser



Efficacy: 101 lm/W
Total luminaire output: 3726 lumens (932 lm/ft)
37 watts (9.3 W/ft)
Peak Candela Value: 1442 @ 0°
CRI: 80 / CCT: 3500K
ITL LM79 Report 85128



CANDELA DISTRIBUTION

	0.0	22.5	45	67.5	90	Flux
0	1442	1442	1442	1442	1442	
5	1434	1434	1433	1433	1434	136
15	1369	1360	1365	1364	1359	384
25	1241	1226	1232	1225	1219	566
35	1064	1053	1055	1043	1037	657
45	864	853	851	840	834	655
55	650	644	640	631	626	571
65	441	436	433	428	425	428
75	238	237	238	237	236	252
85	70	69	70	72	71	78
90	0	0	0	0	0	

Complete LM79 LED Photometry

Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire			
S [1]	**B** [1]	**H** [1]	**V** [2]
1525	1917	2898	3726

Light Output, 3500K, 80 CRI (Lumens Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
381	479	725	932

Power, 3500K (Watts Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
3.6	4.6	7.1	9.3

Efficacy, 3500K, 80 CRI (Lumens Per Watt)			
S [1]	**B** [1]	**H** [1]	**V** [2]
105	104	102	101

Sample Lumen Adjustment Calculation

Lumen Adjustment Factors 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

Lumen Adjustment Factors 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

High Output (**H**), 4000K, 90 CRI

Lumen Adjustment Factor: 0.789

Total Light Output: 2898 lm x 0.789 = 2287 lm

Total Light Output per Foot: 725 lm/ft x 0.789 = 572 lm/ft.

watts/foot: 7.1 W/ft.

$$\textbf{Efficacy} = \frac{572\ \frac{\text{lm}}{\text{ft.}}}{7.1\ \frac{\text{W}}{\text{ft.}}} = 80\ \text{lm/W}$$

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output

[1] Family Correlation based on 4' luminaire 3500K Very High Output (**V**) test - 120V.
[2] Based on ITL report: 85128

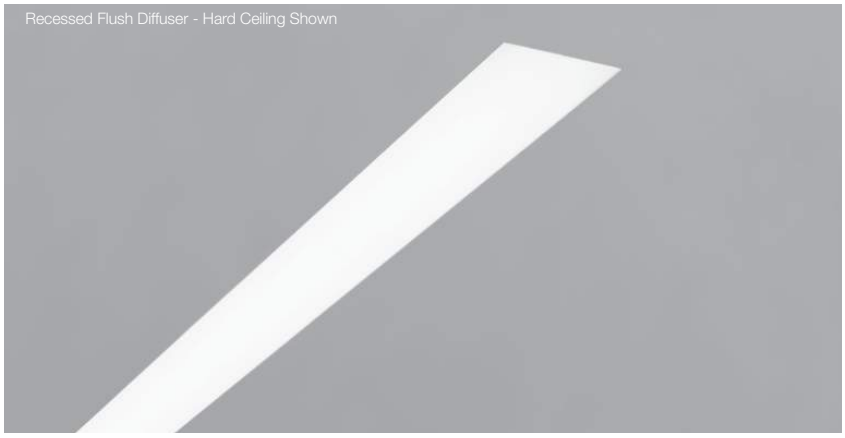
Submitted by:	Date:
Type:	Project:
Ordering Info:	

BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8A

LIGHT FIXTURE REQUIRED TO BE DLC LISTED



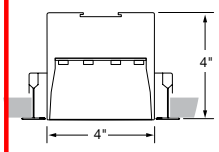
High Performance 4" Aperture is a patented, linear LED luminaire family. HP-4 delivers excellent performance using an advanced optical design and mid-power LEDs. Achieving 90% of initial light output at 100,000+ hours and backed by a 10-year performance-based warranty on all standard components.

This product is enrolled in the International Living Future Institute (ILFI) Declare 2.0 Program and is third-party verified with options achieving Red List Approved and Declared status.

Note: see page 6 for all aesthetic options

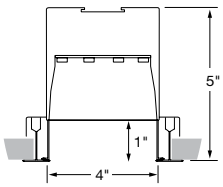
CROSS SECTIONS

Recessed



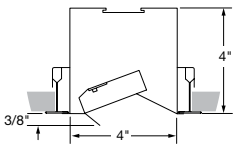
Flush Downlight Diffuser (standard)

Regressed



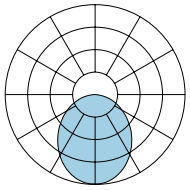
Flat Diffuser with 1" Regressed

Wall Wash Recessed

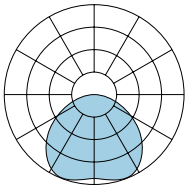


Kicker (standard)

OPTIC OPTIONS



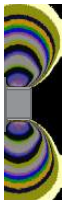
Standard Downlight Optic (**F**)



Downlight Spread Optic (**DSO**)

ALSO AVAILABLE IN

Pendant (**D, ID, I**)



Wall Mount (**WM**)

Surface Mount (**SM**)

Fine TUNE Option Available

Protected by one or more US Patents: 8915613; D702,391; D702,390; D700,732

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FINELITE® Better Lighting

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

High Performance 4" Aperture (HP-4) Recessed L8A Form

BODY TYPE

Platform	Series Name	Luminaire Type	Luminaire Distribution	Total Length of Run
◉ HP - High Performance	◉ 4	◯ R - Recessed ◯ R RG - Recessed Regressed (Wall Wash not available)	◯ D - Direct ◯ WW-D - Wall Wash Direct	40ft Minimum 2' section length. Increments accurate to 1/16" (±1/32"), standard. 12' maximum section length.

OUTPUT and LED TYPE

Downlight Output	LED CRI/CCT
◯ S - Standard ◯ B - Boosted Standard ◯ H - High ◯ V - Very High ◯ TL - Tailored: lm/ft* * Specify lm/ft of outputs between Standard (S) and Very High (V). Consult factory for tailored lumen output outside of this range.	◯ 830 - 80 CRI, 3000K ◯ 835 - 80 CRI, 3500K ◯ 840 - 80 CRI, 4000K ◯ 930 - 90 CRI, 3000K ◯ 935 - 90 CRI, 3500K ◯ 940 - 90 CRI, 4000K ◯ 8TW - 80 CRI, Tunable White ◯ 9TW - 90 CRI, Tunable White

MECHANICAL/OPTICAL OPTIONS

Downlight

- ◯ F - Flush (standard)
- ◯ DL - 1" Drop Down Lens
- ◯ RG-D - Flat Diffuser with 1" Regress [1]
- ◯ RG-WCB - White Cross Blade Baffle [1]
- ◯ RG-LHE - Hollowed Ellipse Louver [1]
- ◯ RG-LHC - Hex Louver [1]
- ◯ DSO - Downlight Spread Optic [2]
- ◯ K - Kicker for Wall Wash only
- ◯ FO - Fully Open for Wall Wash only

Reflector System

- ◯ 96LG - 96 Low Gloss White
- ◯ SSA - Semi-Specular Aluminum for Wall Wash only

ELECTRICAL OPTIONS

Voltage

- ◯ 120 - 120 Voltage
- ◯ 277 - 277 Voltage
- ◯ 347 - 347 Voltage

Circuiting [3]

- ◉ SC - Single Circuit*

* Battery, Night Light, and Emergency to Generator circuits are in addition to the normal luminaire circuit(s)

ELECTRICAL OPTIONS

Driver Selection

0-10V Driver Options

- ◯ FC-10% - 0-10V 10% [4] (standard)
- ◯ FC-1% - 0-10V 1% [4]
- ◯ OSR-10% - Osram OTi, 0-10V 10% [4]
- ◯ OSR-1% - Osram OTi, 0-10V 1% [4]
- ◯ ELD-10V-0% - EldoLED SOLOdrive, 0-10V 0.1%
- ◯ OSR-10V-TW - Osram OTi, 0-10V 10% *(Tunable White)* [4]

DALI Driver Options

- ◯ FC-DALI-1% - DALI 1%
- ◯ OSR-DALI-1% - Osram Dexal, 1%
- ◯ ELD-DALI-0% - EldoLED SOLOdrive, 0.1%
- ◯ ELD-DALI-TW - EldoLED DUALdrive LightShape, 0.1% *(Tunable White)*

DMX Driver Options

- ◯ FIN-DMX - Finelite DMX 1% *(Tunable White - FineTune Controls Only)* [5]
- ◯ ELD-DMX - EldoLED POWERdrive, 0.1%
- ◯ ELD-DMX-TW - EldoLED POWERdrive, 0.1% *(Tunable White)*

Lutron Driver Options

- ◯ LUT-ES1 - Lutron, Ecosystem 1%
- ◯ LUT-ES5 - Lutron, Ecosystem 5%
- ◯ LUT-2W - Lutron, 2-wire (120V only) 1%
- ◯ LUT-TW - Lutron T-Series, EcoSystem 0.1% *(Tunable White)*

See Page 3 for additional driver options and details

MOUNTING OPTIONS

Ceiling Hardware Type

- ◯ C1 - 1" T-Bar
- ◯ C1T - 1" Tegular
- ◯ C2 - 9/16" T-Bar
- ◯ C2T - 9/16" Tegular
- ◯ C3 - Screw Slot
- ◯ C3F - Flush Screw Slot
- ◯ SF - Spackle Flange
- ◯ VF - Visible Flange
- ◯ TZ6 - Tech Zone 6" _____ (C1, C2, C2T, C3, C3F)

OTHER OPTIONS

Endcap Style	Finish	Emergency Style (Optional)	Integrated Sensor (Optional)	Special Options (Optional)
◉ FE - Flat Endcap (standard)	◯ SW - Signal White (standard) ◯ FB - Finelite Black [6] ◯ SA - Satin Aluminum [6] ◯ #### - RAL Color Code [6] _____	◯ FAC CHO - Factory Choice Battery Back-up ◯ EM/GEN - Emergency to Generator ◯ NL - Night Light ◯ ~~BSL722 - Bodine Battery Back-up~~ ◯ BSL310LP - Bodine Battery Back up Low Profile ◯ ~~GTD - Generator Transfer Device~~	◯ OBO - Occupancy [7] ◯ OBD - Daylight [7] ◯ OBE - Enlighted [8] ◯ REE - Remote Enlighted [9]	◯ CP - Chicago Plenum ◯ FLX - Flex Whip ◯ RLA - Red List Approved ◯ RLD - Declared

FOR EM SECTIONS ONLY

[1] Recessed Regressed only
[2] Not available with Regressed or Curves
[3] Contact factory for switching options
[4] Add DTO to gain "Dim to Off" functionality (FC-10% - DTO)
[5] B & V outputs only
[6] 20 busines
[7] Not available with Wall Wash
[8] Enlighted components installed by Finelite, provided by others
[9] Enlighted for Wall Wash fixtures. Enlighted Control Unit & Sensor Cable installed for Remote mounting sensor.

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8A

SUPPLEMENTARY DRIVER PAGE

0-10V Driver Options	
FC-10%	Factory Choice, 0-10V 10% Dimming (Linear)
FC-10%-DTO	Factory Choice, 0-10V 10% Dimming, Dim-to-Off (Linear)
FC-1%	Factory Choice, 0-10V 1% Dimming (Linear)
FC-1%-DTO	Factory Choice, 0-10V 1% Dimming, Dim-to-Off (Linear)
ELD-10V-0%	EldoLED SOLOdrive, 0-10V 0.1% Dimming (Linear)
ELD-10V-1%	EldoLED ECOdrive, 0-10V 1% Dimming (Linear)
OSR-10V-TW	Osram OTi, 0-10V 10% Dimming, *Tunable White* (Linear)
OSR-10V-TW-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off, *Tunable White* (Linear)
OSR-10%	Osram OTi, 0-10V 10% Dimming (Linear)
OSR-10%-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off (Linear)
OSR-1%	Osram OTi, 0-10V 1% Dimming (Linear)
OSR-1%-DTO	Osram OTi, 0-10V 1% Dimming, Dim-to-Off (Linear)

DALI Driver Options	
FC-DALI-1%	Factory Choice, DALI 1% Dimming (Logarithmic)
OSR-DALI-1%	Osram Dexal, DALI 1% Dimming (Logarithmic)
ELD-DALI-0%	EldoLED SOLOdrive, DALI 0.1% Dimming (Logarithmic)
ELD-DALI-1%	EldoLED ECOdrive, DALI 1% Dimming (Logarithmic)
ELD-DALI-TW	EldoLED DUALdrive Light Shape, DALI 0.1% Dimming, *Tunable White* (Logarithmic Dimming, Linear CCT Control)

DMX Driver Options	
FIN-DMX	Finelite, DMX 1% Dimming, *Tunable White* - **FineTUNE Controls Only** (Linear)
ELD-DMX	EldoLED POWERdrive, DMX 0.1% Dimming (8 Bit, 1CH) (Linear)
ELD-DMX-16	EldoLED POWERdrive, DMX 0.1% Dimming (16 Bit, 2CH) (Linear)
ELD-DMX-TW	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (8 Bit, 2CH - CH1 Warm / CH2 Cool) (Linear)
ELD-DMX-TW16	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (16 Bit, 4CH - CH1, 2 Warm / CH3, 4 Cool) (Linear)

Lutron Driver Options	
LUT-ES1	Lutron, Ecosystem 1% Dimming
LUT-ES5	Lutron, Ecosystem 5% Dimming
LUT-2W	Lutron, 2-wire (120V only) 1% Dimming
LUT-TW	Lutron T-Series, EcoSystem 0.1% Dimming, *Tunable White*

Submitted by:	Date:
Type:	Project:
Ordering Info:	

BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8A

SPECIFICATIONS

BODY TYPE

CONSTRUCTION: Precision-cut 6061-T6 extruded aluminum body. Internal joiner system, plug-together wiring, standard.

LENGTHS: Any length, 2' minimum, in increments down to 1/16" (±1/32"). 12' maximum section length. Hollowed Ellipse Louver (**LHE**), Hex Louver (**LHC**), and White Cross Blade Baffle (**WCB**) are available in 1' increments.

MITERED CORNERS [1]: Illuminated corners of greater than 60° and less than 180° in a single plane, available with Flush Diffuser, Bottom Glow Diffuser, 1" Drop Down Lens, Regressed Diffuser, White Cross Blade Baffle[2] or Wall Wash. Corners not available with Wall Wash (**WW-D**), Hollowed Ellipse Louver (**LHE**) or Hex Louver (**LHC**). Consult factory for tailored lighting options.

OUTPUT AND LED TYPE

LIGHT OUTPUT: Four lumen packages available, Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). For lengths 3' and greater, the uplight and downlight can be specified with different lumen packages and dual controls. For Tailored Outputs outside of range from Standard (**S**) to Very High (**V**), consult factory. Light engines are replaceable.

MECHANICAL/OPTICAL OPTIONS

DOWNLIGHT OPTION : 12' maximum diffuser length. Flush frost white snap-in diffuser standard, 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination. Available with Flush (**F**), 1" Drop Down Lens (**DL**), White Cross Blade Baffle (**WCB**) [3, 4], Ellipse Louver (**LHE**) [3], Hex Louver (**LHC**) [3], Downlight Spread Optic (**DSO**), and Regressed downlight diffusers (**RG**) [3]. 1" Drop Down Lens made of acrylic. Available with a solid endcap or an endcap with a diffuse filler to continue the luminous aesthetic. Downlight Spread Optic is an extruded lens with a subtle ribbed appearance providing a batwing distribution for improved optical performance. Consult factory for more tailored lumen outputs.

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

REFLECTORS: Die-formed 20-gauge cold-rolled steel reflectors finished in 96LG High Reflectance white powder coat paint. The standard Semi-Specular Aluminum (**SSA**) Kicker (**K**) reflector delivers light high on the vertical surface. The Kicker reflector can be easily removed for open distribution (**FO**).

ELECTRICAL OPTIONS

STATIC WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed wire controlling uplight and downlight together (power and dimming). Specify dual feed wires for independent control of uplight and downlight. 14-gauge feed wire used when luminaire current exceeds 5 amps.

TUNABLE WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when luminaire current exceeds 5 amps. DMX and power feed at same location (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths.

STATIC WHITE DRIVER: Replaceable 120V, 277V, and 347V constant current reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 10%- 100% standard. Dimming to 1% available. Separate dimming for uplight and downlight available. Driver is fully accessible from below the ceiling.
- **Power Factor:** ≥ 0.9
- **Total Harmonic Distortion (THD):** <20%
- **Expected driver lifetime:** 100,000 hours

LUTRON DRIVER OPTIONS:
- **LUTES1** (Hi-lume 1% EcoSystem with Soft-On, Fade-to-Black dimming (LDE1 series))
- **LUTES5** (5-Series 5% EcoSystem (LDE5 Series))
- **LUT2W** (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)).

TUNABLE WHITE DRIVER: Replaceable LED driver. Driver is accessible from below the ceiling. 120V, 277V, and 347V.
- **Power factor:** ≥0.90
- **Total Harmonic Distortion (THD):** <20%
- **Dimming Range:** 100%-10%
- **Expected driver lifetime:** 100,000 hours
- FineTune DMX is 1%

LUTRON TUNABLE WHITE DRIVER OPTION:
LUT-TW (0.1% T-Series 2-Channel Digital Tunable White (PSQ Series)).

MOUNTING OPTIONS

HANGING HARDWARE:
- **Recessed T-Bar:** Standard bracket design works with most lay-in ceiling types. Brackets secure luminaire to the ceiling grid from above. Tie-in T-Bar brackets connect the luminaire to the T-Bar for securing to structure. Consult local codes for tie-wire recommendations.
- **Recessed Spackle Flange:** Drywall surfaces (walls or ceilings): 1/4" - 20 stud and nut (provided by others). Mounted with three equidistant suspension points.

[1] Not available with Wall Wash
[2] White Cross Blade (WCB) baffles not available with custom angles. Available in 90 degrees only
[3] Recessed-Regressed only
[4] White Cross Blade Baffle (WCB) currently not advisable for drywall

Continued

Submitted by:	Date:
Type:	Project:
Ordering Info:	

BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8A

SPECIFICATIONS

TUNABLE WHITE DMX HANGING HARDWARE: For grid ceiling applications the dual GridBox™ mounting is supplied (standard). For hard ceiling applications the ceiling mounting box is supplied (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths. Available DMX pendant feed lengths are 5' (standard), 12', and 30'.

TUNABLE WHITE DMX INTERCONNECTION CABLES: Luminaires are pre-wired with plug-and-play interconnection cables to support easy plug-together joining of fixture runs. If a non-FineTune DMX system has been specified, a DMX to RJ45 converter is provided.

OTHER OPTIONS

ENDCAPS: Flat endcaps (**FE**) at each end of run add 1/16" to each end of luminaire. Drop Down Lens Illuminated Endcap (**DE**) includes diffuse element to continue luminance of drop lens.

EMERGENCY STYLE: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, step-dimming driver, backup battery.

Backup Battery			
	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-R-D			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'
HP4-R-WW-D			
Min. Housing Length	8'*	4'*	4'*
EM Lumen Output	2000	1189	2000
EM Section Illum.	4'	4'	4'

* Minimum fixture housing length for battery pack approved without sensor

TUNABLE WHITE ELECTRICAL OPTIONS[5]:
- **TW Driver Options 0-10V:** EM/GEN, GTD or Battery Back up
- **FineTune DMX:** EM/GEN or Battery Back up
- **DMX:** Battery Back up
- **DALI:** EM/GEN, GTD or Battery Back up
- **LUTRON:** EM/GEN, GTD or Battery Back up

INTEGRATED SENSORS: Integrated PIR (Passive Infrared) occupancy or daylight sensors available with Flush and Bottom Glow downlight diffusers. Refer to Occupancy Sensor, Daylight Sensor, and Enlighted Sensor tech sheets for more info.

FINISHES: Finelite Signal White (**SW**) powder coat, Finelite Black (RAL 9005) with semi gloss fine texture (**FB**)[6], and Satin Aluminum (**SA**)[6] are standard. Optional Adder: 185 RAL colors[6] are available.

LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.130 (G), this luminaire contains an internal driver disconnect. UL 924 and UL 2108 - PoE options available on request.These fixtures are rated for Damp Location. IC Rated. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2015/863. Consult factory for tailored lighting options. Finelite makes the specification process easy when putting healthier products on your projects. Simply add – **RLA** (Red List Approved) or – **RLD** (Declared Label) to your part number.

WEIGHT[7]: R - 2.8 lb/ft; WW-R - 2.9 lb/ft

DLC QUALIFIED: Configurations of this product are listed on the DLC Qualified Products List (QPL). www.designlights.org/search

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

[5] Consult Finelite for Generator Transfer Device and Battery Backup fit
[6] 20 business days lead time for color
[7] Excludes Battery Backup and Generator Transfer Device weight

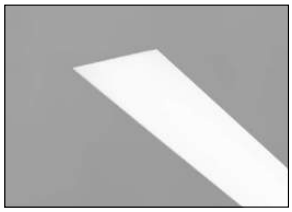
Submitted by:		Date:
Type:	Project:	
Ordering Info:		

BUY AMERICAN ACT OF 2009 COMPLIANT

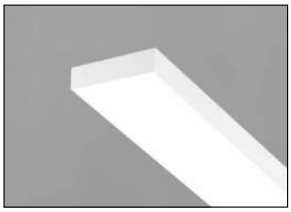
FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8A

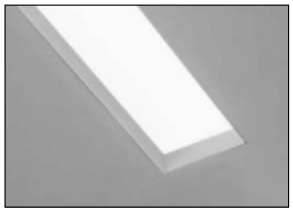
AESTHETIC OPTIONS



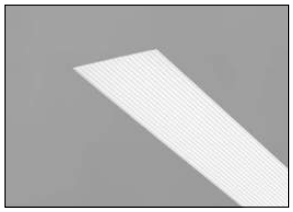
Flush Diffuser (**F**)



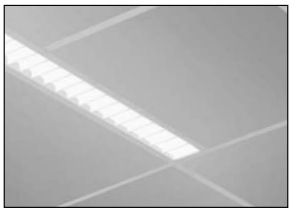
1" Drop Down Lens (**DL**)



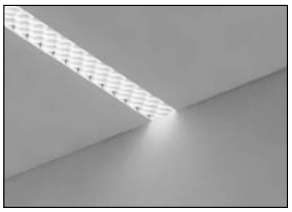
Flat Diffuser with 1" Regressed (**RG-D**)



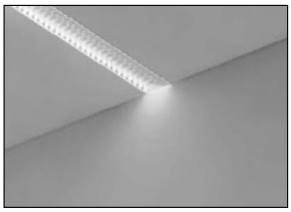
Downlight Spread Optic (**DSO**)
Externally flush



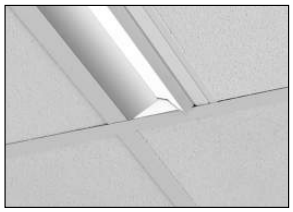
White Cross Blade Baffle[1] (**RG-WCB**)



Hex Louver[1] (**RG-LHC**)



Hollowed Ellipse Louver[1] (**RG-LHE**)



Kicker (**K**) - Wall Wash only

[1] Regressed only

Submitted by:	Date:
Type:	Project:
Ordering Info:	

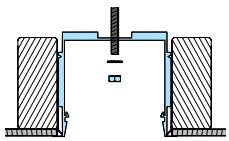
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

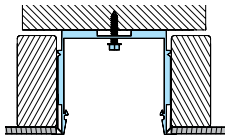
High Performance 4" Aperture (HP-4) Recessed L8A

HARD CEILING MOUNTING OPTIONS

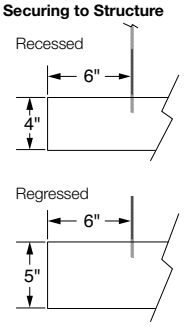
Threaded Rod Option



Screw Mount Option

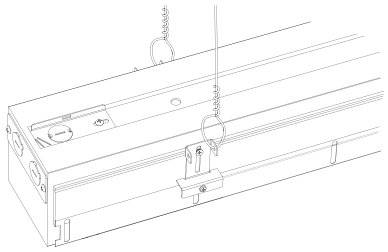


Mounting Location for Securing to Structure



Two mounting options: threaded rod and screw mounting options. Mounting locations are located on each end of the luminaire. Mounting location is 6" away from each end of luminaire.

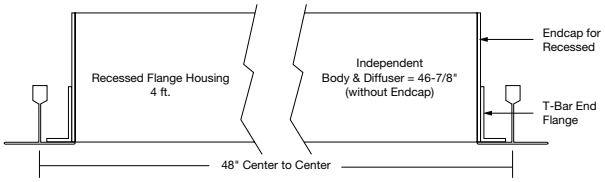
T-BAR INSTALLATION



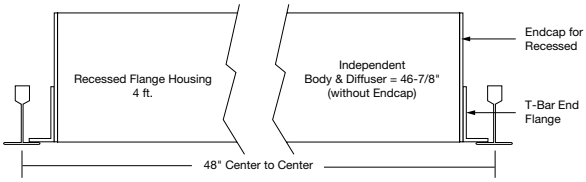
HP-4 R for T-Bar installations comes standard with a splice plate at the end of the luminaire. Mounting brackets (supplied) secure the luminaire to T-Bar and provide support to structure location. All even foot length (2, 4, 6, ...) luminaire runs are reduced in length by an appropriate amount to fit within typical 2x2 and 2x4 T-Bar grid systems. For uncommon T-Bar systems please consult factory.

GRID LENGTH DETAIL - 4' EXAMPLE

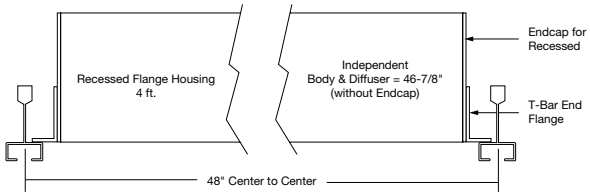
1" T-Bar



9/16" T-Bar

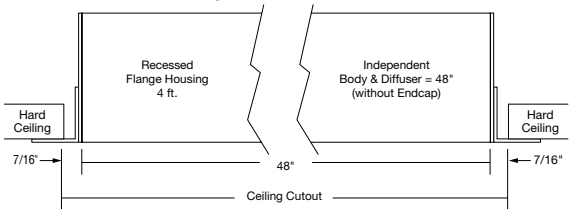


9/16" Screw Slot

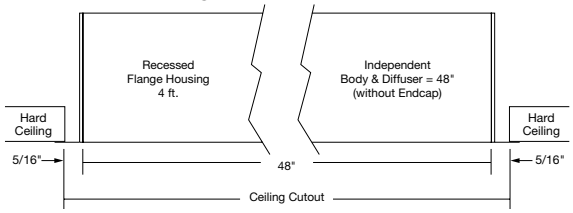


HARD CEILING LENGTH DETAIL - 4' EXAMPLE

Spackle Flange



Visible Flange



Submitted by:		Date:
Type:	Project:	
Ordering Info:		

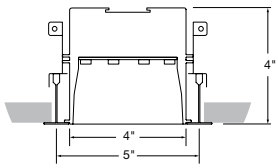
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

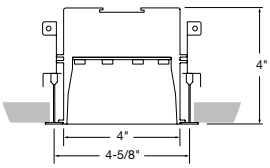
High Performance 4" Aperture (HP-4) Recessed L8A

RECESSED MOUNTING TYPES - T-BAR

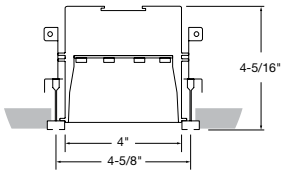
Rough-In Dimensions



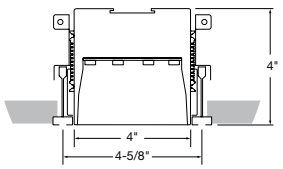
1" T-Bar (C1)



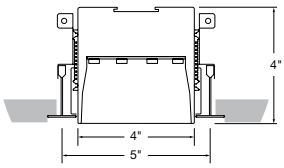
9/16" T-Bar (C2)



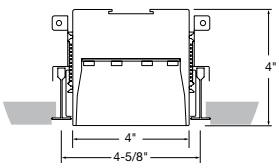
Standard Screw Slot (C3)



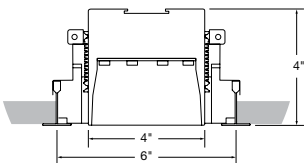
Flush Screw Slot (C3F)



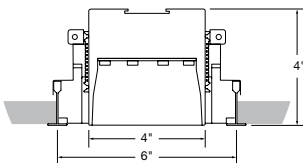
1" Tegular (C1T)



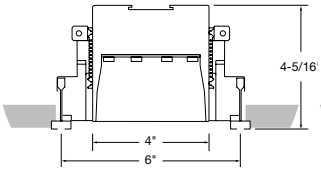
9/16" Tegular (C2T)



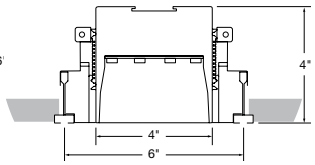
Tech Zone 6" (TZ6)
1" T-Bar (C1)



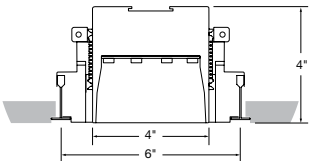
Tech Zone 6" (TZ6)
9/16" T-Bar (C2)



Tech Zone 6" (TZ6)
Standard Screw Slot (C3)

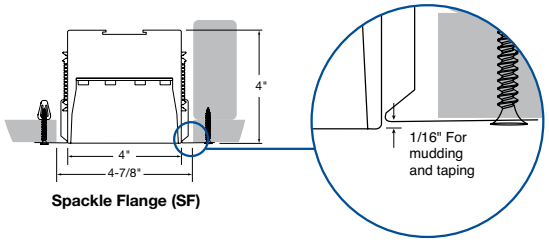


Tech Zone 6" (TZ6)
Flush Screw Slot (C3F)

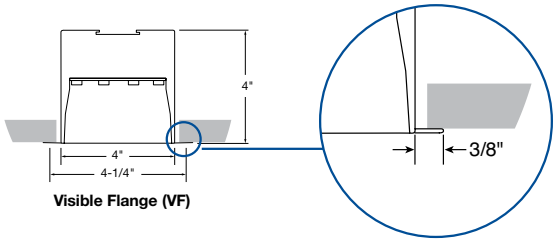


Tech Zone 6" (TZ6)
9/16" Tegular (C2T)

RECESSED MOUNTING TYPES - CUTOUT DIMENSIONS



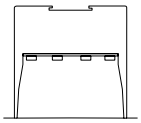
Spackle Flange (SF)



Visible Flange (VF)

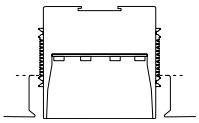
HOUSING

Version 1



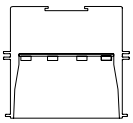
Ceiling Option VF

Version 2



Ceiling Options
C1T, C2T, C3F, SF, TZ6

Version 3



Ceiling Options
C1, C2, C3

Note: +/- 1/16"

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

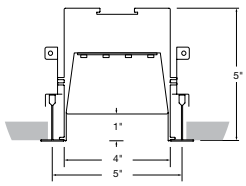
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE®
Better Lighting

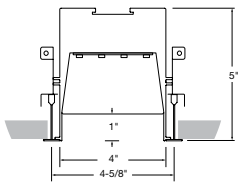
High Performance 4" Aperture (HP-4) Recessed L8A

REGRESSED MOUNTING TYPES - T-BAR

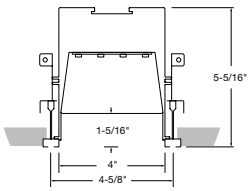
Rough-In Dimensions



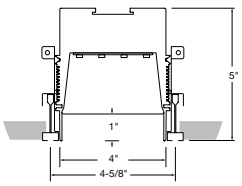
1" T-Bar (C1)



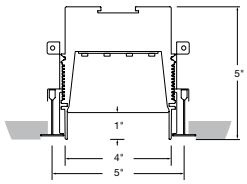
9/16" T-Bar (C2)



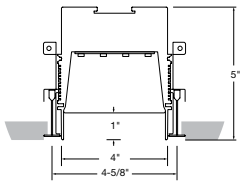
Standard Screw Slot (C3)



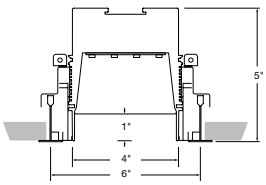
Flush Screw Slot (C3F)



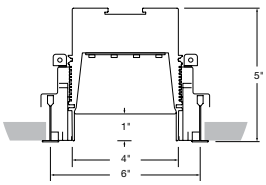
1" Tegular (C1T)



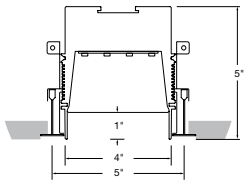
9/16" Tegular (C2T)



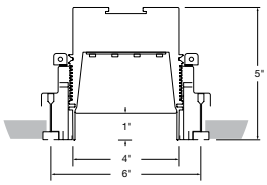
Tech Zone 6" (TZ6)
1" T-Bar (C1)



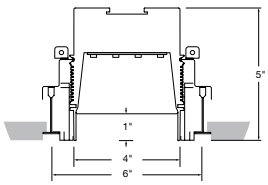
Tech Zone 6" (TZ6)
9/16" T-Bar (C2)



Tech Zone 6" (TZ6)
Standard Screw Slot (C3)

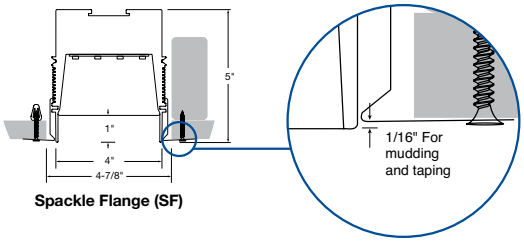


Tech Zone 6" (TZ6)
Flush Screw Slot (C3F)

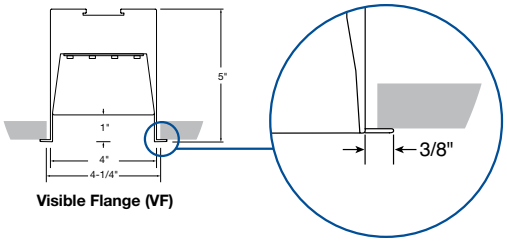


Tech Zone 6" (TZ6)
9/16" Tegular (C2T)

REGRESSED MOUNTING TYPES - CUTOUT DIMENSIONS



Spackle Flange (SF)

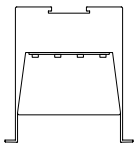


Visible Flange (VF)

Regressed Lens: Regressed lens version is 5" tall with a lens that is regressed 1" from ceiling line.

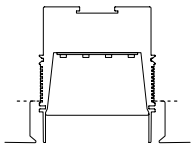
HOUSING

Version 1



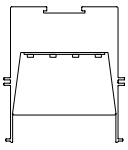
Ceiling Option VF

Version 2



Ceiling Options
C1T, C2T, C3F, SF, TZ6

Version 3



Ceiling Options
C1, C2, C3

Note: +/- 1/16"

Submitted by:	Date:
Type:	Project:
Ordering Info:	

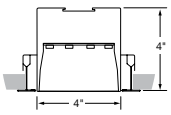
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

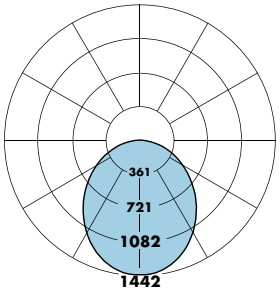
High Performance 4" Aperture (HP-4) Recessed L8A

Recessed Photometry - 4' Luminaire 3500K

HP4-R-D-4'-V-835
Downlight: Flush Diffuser



Efficacy: 101 lm/W
Total luminaire output: 3726 lumens (932 lm/ft)
37 watts (9.3 W/ft)
Peak Candela Value: 1442 @ 0°
CRI: 80 / CCT: 3500K
ITL LM79 Report 85128



CANDELA DISTRIBUTION

	0.0	22.5	45	67.5	90	Flux
0	1442	1442	1442	1442	1442	
5	1434	1434	1433	1433	1434	136
15	1369	1360	1365	1364	1359	384
25	1241	1226	1232	1225	1219	566
35	1064	1053	1055	1043	1037	657
45	864	853	851	840	834	655
55	650	644	640	631	626	571
65	441	436	433	428	425	428
75	238	237	238	237	236	252
85	70	69	70	72	71	78
90	0	0	0	0	0	

Complete LM79 LED Photometry

Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire			
S [1]	**B** [1]	**H** [1]	**V** [2]
1525	1917	2898	3726
Light Output, 3500K, 80 CRI (Lumens Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
381	479	725	932
Power, 3500K (Watts Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
3.6	4.6	7.1	9.3
Efficacy, 3500K, 80 CRI (Lumens Per Watt)			
S [1]	**B** [1]	**H** [1]	**V** [2]
105	104	102	101

Sample Lumen Adjustment Calculation

Lumen Adjustment Factors 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

Lumen Adjustment Factors 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

High Output (**H**), 4000K, 90 CRI

Lumen Adjustment Factor: 0.789

Total Light Output: 2898 lm x 0.789 = 2287 lm

Total Light Output per Foot: 725 lm/ft x 0.789 = 572 lm/ft.

watts/foot: 7.1 W/ft.

$$\textbf{Efficacy} = \frac{572\ \frac{\text{lm}}{\text{ft.}}}{7.1\ \frac{\text{W}}{\text{ft.}}} = 80\ \text{lm/W}$$

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output

[1] Family Correlation based on 4' luminaire 3500K Very High Output (**V**) test - 120V.
[2] Based on ITL report: 85128

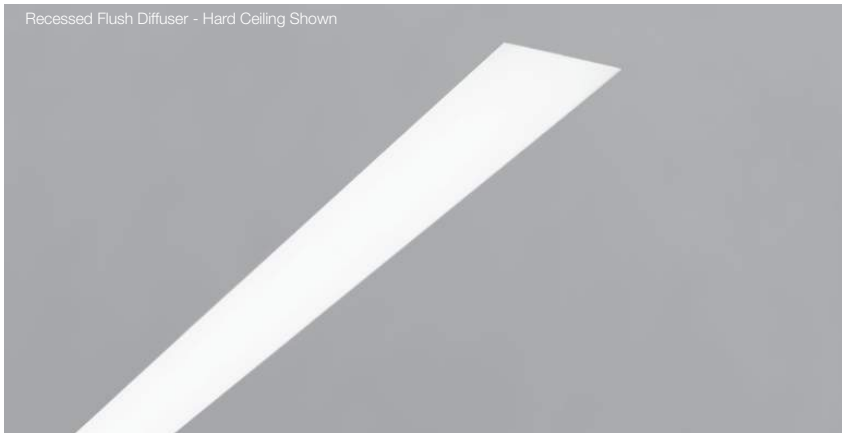
Submitted by:	Date:
Type:	Project:
Ordering Info:	

BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE®
Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8B

LIGHT FIXTURE REQUIRED TO BE DLC LISTED



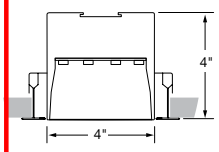
High Performance 4" Aperture is a patented, linear LED luminaire family. HP-4 delivers excellent performance using an advanced optical design and mid-power LEDs. Achieving 90% of initial light output at 100,000+ hours and backed by a 10-year performance-based warranty on all standard components.

This product is enrolled in the International Living Future Institute (ILFI) Declare 2.0 Program and is third-party verified with options achieving Red List Approved and Declared status.

Note: see page 6 for all aesthetic options

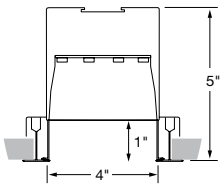
CROSS SECTIONS

Recessed



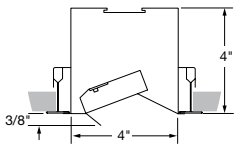
Flush Downlight Diffuser
(standard)

Regressed



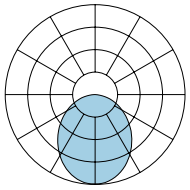
Flat Diffuser with
1" Regressed

Wall Wash Recessed

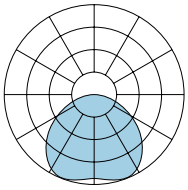


Kicker
(standard)

OPTIC OPTIONS



Standard Downlight Optic
(**F**)



Downlight Spread Optic
(**DSO**)

ALSO AVAILABLE IN

Pendant
(**D, ID, I**)

Wall Mount
(**WM**)

Surface Mount
(**SM**)

Option Available

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18-719
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Bids

Luminaire Product Data
26 5700 - 88
H+B

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FINELITE® Better Lighting

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

High Performance 4" Aperture (HP-4) Recessed L8B Form

BODY TYPE

Platform	Series Name	Luminaire Type	Luminaire Distribution	Total Length of Run
◉ HP - High Performance	◉ 4	◯ R - Recessed ◯ R RG - Recessed Regressed (Wall Wash not available)	◯ D - Direct ◯ WW-D - Wall Wash Direct	8ft Minimum 2' section length. Increments accurate to 1/16" (±1/32"), standard. 12' maximum section length.

OUTPUT and LED TYPE

Downlight Output	LED CRI/CCT
◯ S - Standard ◯ B - Boosted Standard ◯ H - High ◯ V - Very High ◯ TL - Tailored: _____ lm/ft* * Specify lm/ft of outputs between Standard (S) and Very High (V). Consult factory for tailored lumen output outside of this range.	◯ 830 - 80 CRI, 3000K ◯ 835 - 80 CRI, 3500K ◯ 840 - 80 CRI, 4000K ◯ 930 - 90 CRI, 3000K ◯ 935 - 90 CRI, 3500K ◯ 940 - 90 CRI, 4000K ◯ 8TW - 80 CRI, Tunable White ◯ 9TW - 90 CRI, Tunable White

MECHANICAL/OPTICAL OPTIONS

Downlight

- ◯ F - Flush (standard)
- ◯ DL - 1" Drop Down Lens
- ◯ RG-D - Flat Diffuser with 1" Regress [1]
- ◯ RG-WCB - White Cross Blade Baffle [1]
- ◯ RG-LHE - Hollowed Ellipse Louver [1]
- ◯ RG-LHC - Hex Louver [1]
- ◯ DSO - Downlight Spread Optic [2]
- ◯ K - Kicker for Wall Wash only
- ◯ FO - Fully Open for Wall Wash only

Reflector System

- ◯ 96LG - 96 Low Gloss White
- ◯ SSA - Semi-Specular Aluminum for Wall Wash only

ELECTRICAL OPTIONS

Voltage

- ◯ 120 - 120 Voltage
- ◯ 277 - 277 Voltage
- ◯ 347 - 347 Voltage

Circuiting [3]

- ◉ SC - Single Circuit*

* Battery, Night Light, and Emergency to Generator circuits are in addition to the normal luminaire circuit(s)

ELECTRICAL OPTIONS

Driver Selection

0-10V Driver Options

- ◯ FC-10% - 0-10V 10% [4] (standard)
- ◯ FC-1% - 0-10V 1% [4]
- ◯ OSR-10% - Osram OTi, 0-10V 10% [4]
- ◯ OSR-1% - Osram OTi, 0-10V 1% [4]
- ◯ ELD-10V-0% - EldoLED SOLOdrive, 0-10V 0.1%
- ◯ OSR-10V-TW - Osram OTi, 0-10V 10% *(Tunable White)* [4]

DALI Driver Options

- ◯ FC-DALI-1% - DALI 1%
- ◯ OSR-DALI-1% - Osram Dexal, 1%
- ◯ ELD-DALI-0% - EldoLED SOLOdrive, 0.1%
- ◯ ELD-DALI-TW - EldoLED DUALdrive LightShape, 0.1% *(Tunable White)*

DMX Driver Options

- ◯ FIN-DMX - Finelite DMX 1% *(Tunable White - FineTune Controls Only)* [5]
- ◯ ELD-DMX - EldoLED POWERdrive, 0.1%
- ◯ ELD-DMX-TW - EldoLED POWERdrive, 0.1% *(Tunable White)*

Lutron Driver Options

- ◯ LUT-ES1 - Lutron, Ecosystem 1%
- ◯ LUT-ES5 - Lutron, Ecosystem 5%
- ◯ LUT-2W - Lutron, 2-wire (120V only) 1%
- ◯ LUT-TW - Lutron T-Series, EcoSystem 0.1% *(Tunable White)*

See Page 3 for additional driver options and details

MOUNTING OPTIONS

Ceiling Hardware Type

- ◯ C1 - 1" T-Bar
- ◯ C1T - 1" Tegular
- ◯ C2 - 9/16" T-Bar
- ◯ C2T - 9/16" Tegular
- ◯ C3 - Screw Slot
- ◯ C3F - Flush Screw Slot
- ◯ SF - Spackle Flange
- ◯ VF - Visible Flange
- ◯ TZ6 - Tech Zone 6" _____ (C1, C2, C2T, C3, C3F)

OTHER OPTIONS

Endcap Style

- ◉ FE - Flat Endcap (standard)

Finish

- ◯ SW - Signal White (standard)
- ◯ FB - Finelite Black [6]
- ◯ SA - Satin Aluminum [6]
- ◯ #### - RAL Color Code [6] _____

Emergency Style (Optional)

- ◯ FAC CHO - Factory Choice Battery Back-up
- ◯ EM/GEN - Emergency to Generator
- ◯ NL - Night Light
- ◯ BSL722 - Bodine Battery Back up
- ◯ BSL310LP - Bodine Battery Back up Low Profile
- ◯ GTD - Generator Transfer Device

Integrated Sensor (Optional)

- ◯ OBO - Occupancy [7]
- ◯ OBD - Daylight [7]
- ◯ OBE - Enlighted [8]
- ◯ REE - Remote Enlighted [9]

Special Options (Optional)

- ◯ CP - Chicago Plenum
- ◯ FLX - Flex Whip
- ◯ RLA - Red List Approved
- ◯ RLD - Declared

[1] Recessed Regressed only
[2] Not available with Regressed or Curves
[3] Contact factory for switching options
[4] Add DTO to gain "Dim to Off" functionality (FC-10% - DTO)
[5] B & V outputs only
[6] 20 business days lead time for color
[7] Not available with Wall Wash
[8] Enlighted components installed by Finelite, provided by others
[9] Enlighted for Wall Wash fixtures. Enlighted Control Unit & Sensor Cable installed for Remote mounting sensor.

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Type:	Project:
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FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8B

SUPPLEMENTARY DRIVER PAGE

0-10V Driver Options	
FC-10%	Factory Choice, 0-10V 10% Dimming (Linear)
FC-10%-DTO	Factory Choice, 0-10V 10% Dimming, Dim-to-Off (Linear)
FC-1%	Factory Choice, 0-10V 1% Dimming (Linear)
FC-1%-DTO	Factory Choice, 0-10V 1% Dimming, Dim-to-Off (Linear)
ELD-10V-0%	EldoLED SOLOdrive, 0-10V 0.1% Dimming (Linear)
ELD-10V-1%	EldoLED ECOdrive, 0-10V 1% Dimming (Linear)
OSR-10V-TW	Osram OTi, 0-10V 10% Dimming, *Tunable White* (Linear)
OSR-10V-TW-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off, *Tunable White* (Linear)
OSR-10%	Osram OTi, 0-10V 10% Dimming (Linear)
OSR-10%-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off (Linear)
OSR-1%	Osram OTi, 0-10V 1% Dimming (Linear)
OSR-1%-DTO	Osram OTi, 0-10V 1% Dimming, Dim-to-Off (Linear)

DALI Driver Options	
FC-DALI-1%	Factory Choice, DALI 1% Dimming (Logarithmic)
OSR-DALI-1%	Osram Dexal, DALI 1% Dimming (Logarithmic)
ELD-DALI-0%	EldoLED SOLOdrive, DALI 0.1% Dimming (Logarithmic)
ELD-DALI-1%	EldoLED ECOdrive, DALI 1% Dimming (Logarithmic)
ELD-DALI-TW	EldoLED DUALdrive Light Shape, DALI 0.1% Dimming, *Tunable White* (Logarithmic Dimming, Linear CCT Control)

DMX Driver Options	
FIN-DMX	Finelite, DMX 1% Dimming, *Tunable White* - **FineTUNE Controls Only** (Linear)
ELD-DMX	EldoLED POWERdrive, DMX 0.1% Dimming (8 Bit, 1CH) (Linear)
ELD-DMX-16	EldoLED POWERdrive, DMX 0.1% Dimming (16 Bit, 2CH) (Linear)
ELD-DMX-TW	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (8 Bit, 2CH - CH1 Warm / CH2 Cool) (Linear)
ELD-DMX-TW16	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (16 Bit, 4CH - CH1, 2 Warm / CH3, 4 Cool) (Linear)

Lutron Driver Options	
LUT-ES1	Lutron, Ecosystem 1% Dimming
LUT-ES5	Lutron, Ecosystem 5% Dimming
LUT-2W	Lutron, 2-wire (120V only) 1% Dimming
LUT-TW	Lutron T-Series, EcoSystem 0.1% Dimming, *Tunable White*

Submitted by:	Date:
Type:	Project:
Ordering Info:	

BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8B

SPECIFICATIONS

BODY TYPE

CONSTRUCTION: Precision-cut 6061-T6 extruded aluminum body. Internal joiner system, plug-together wiring, standard.

LENGTHS: Any length, 2' minimum, in increments down to 1/16" (±1/32"). 12' maximum section length. Hollowed Ellipse Louver (**LHE**), Hex Louver (**LHC**), and White Cross Blade Baffle (**WCB**) are available in 1' increments.

MITERED CORNERS [1]: Illuminated corners of greater than 60° and less than 180° in a single plane, available with Flush Diffuser, Bottom Glow Diffuser, 1" Drop Down Lens, Regressed Diffuser, White Cross Blade Baffle[2] or Wall Wash. Corners not available with Wall Wash (**WW-D**), Hollowed Ellipse Louver (**LHE**) or Hex Louver (**LHC**). Consult factory for tailored lighting options.

OUTPUT AND LED TYPE

LIGHT OUTPUT: Four lumen packages available, Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). For lengths 3' and greater, the uplight and downlight can be specified with different lumen packages and dual controls. For Tailored Outputs outside of range from Standard (**S**) to Very High (**V**), consult factory. Light engines are replaceable.

MECHANICAL/OPTICAL OPTIONS

DOWNLIGHT OPTION : 12' maximum diffuser length. Flush frost white snap-in diffuser standard, 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination. Available with Flush (**F**), 1" Drop Down Lens (**DL**), White Cross Blade Baffle (**WCB**) [3, 4], Ellipse Louver (**LHE**) [3], Hex Louver (**LHC**) [3], Downlight Spread Optic (**DSO**), and Regressed downlight diffusers (**RG**) [3]. 1" Drop Down Lens made of acrylic. Available with a solid endcap or an endcap with a diffuse filler to continue the luminous aesthetic. Downlight Spread Optic is an extruded lens with a subtle ribbed appearance providing a batwing distribution for improved optical performance. Consult factory for more tailored lumen outputs.

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

REFLECTORS: Die-formed 20-gauge cold-rolled steel reflectors finished in 96LG High Reflectance white powder coat paint. The standard Semi-Specular Aluminum (**SSA**) Kicker (**K**) reflector delivers light high on the vertical surface. The Kicker reflector can be easily removed for open distribution (**FO**).

ELECTRICAL OPTIONS

STATIC WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed wire controlling uplight and downlight together (power and dimming). Specify dual feed wires for independent control of uplight and downlight. 14-gauge feed wire used when luminaire current exceeds 5 amps.

TUNABLE WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when luminaire current exceeds 5 amps. DMX and power feed at same location (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths.

STATIC WHITE DRIVER: Replaceable 120V, 277V, and 347V constant current reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 10%- 100% standard. Dimming to 1% available. Separate dimming for uplight and downlight available. Driver is fully accessible from below the ceiling.
- **Power Factor:** ≥ 0.9
- **Total Harmonic Distortion (THD):** <20%
- **Expected driver lifetime:** 100,000 hours

LUTRON DRIVER OPTIONS:
- **LUTES1** (Hi-lume 1% EcoSystem with Soft-On, Fade-to-Black dimming (LDE1 series))
- **LUTES5** (5-Series 5% EcoSystem (LDE5 Series))
- **LUT2W** (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)).

TUNABLE WHITE DRIVER: Replaceable LED driver. Driver is accessible from below the ceiling. 120V, 277V, and 347V.
- **Power factor:** ≥0.90
- **Total Harmonic Distortion (THD):** <20%
- **Dimming Range:** 100%-10%
- **Expected driver lifetime:** 100,000 hours
- FineTune DMX is 1%

LUTRON TUNABLE WHITE DRIVER OPTION:
LUT-TW (0.1% T-Series 2-Channel Digital Tunable White (PSQ Series)).

MOUNTING OPTIONS

HANGING HARDWARE:
- **Recessed T-Bar:** Standard bracket design works with most lay-in ceiling types. Brackets secure luminaire to the ceiling grid from above. Tie-in T-Bar brackets connect the luminaire to the T-Bar for securing to structure. Consult local codes for tie-wire recommendations.
- **Recessed Spackle Flange:** Drywall surfaces (walls or ceilings): 1/4" - 20 stud and nut (provided by others). Mounted with three equidistant suspension points.

[1] Not available with Wall Wash
[2] White Cross Blade (WCB) baffles not available with custom angles. Available in 90 degrees only
[3] Recessed-Regressed only
[4] White Cross Blade Baffle (WCB) currently not advisable for drywall

Continued

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

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FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Recessed L8B

SPECIFICATIONS

TUNABLE WHITE DMX HANGING HARDWARE: For grid ceiling applications the dual GridBox™ mounting is supplied (standard). For hard ceiling applications the ceiling mounting box is supplied (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths. Available DMX pendant feed lengths are 5' (standard), 12', and 30'.

TUNABLE WHITE DMX INTERCONNECTION CABLES: Luminaires are pre-wired with plug-and-play interconnection cables to support easy plug-together joining of fixture runs. If a non-FineTune DMX system has been specified, a DMX to RJ45 converter is provided.

OTHER OPTIONS

ENDCAPS: Flat endcaps (**FE**) at each end of run add 1/16" to each end of luminaire. Drop Down Lens Illuminated Endcap (**DE**) includes diffuse element to continue luminance of drop lens.

EMERGENCY STYLE: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, step-dimming driver, backup battery.

Backup Battery			
	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-R-D			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'
HP4-R-WW-D			
Min. Housing Length	8'*	4'*	4'*
EM Lumen Output	2000	1189	2000
EM Section Illum.	4'	4'	4'

* Minimum fixture housing length for battery pack approved without sensor

TUNABLE WHITE ELECTRICAL OPTIONS[5]:
- **TW Driver Options 0-10V:** EM/GEN, GTD or Battery Back up
- **FineTune DMX:** EM/GEN or Battery Back up
- **DMX:** Battery Back up
- **DALI:** EM/GEN, GTD or Battery Back up
- **LUTRON:** EM/GEN, GTD or Battery Back up

INTEGRATED SENSORS: Integrated PIR (Passive Infrared) occupancy or daylight sensors available with Flush and Bottom Glow downlight diffusers. Refer to Occupancy Sensor, Daylight Sensor, and Enlighted Sensor tech sheets for more info.

FINISHES: Finelite Signal White (**SW**) powder coat, Finelite Black (RAL 9005) with semi gloss fine texture (**FB**)[6], and Satin Aluminum (**SA**)[6] are standard. Optional Adder: 185 RAL colors[6] are available.

LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.130 (G), this luminaire contains an internal driver disconnect. UL 924 and UL 2108 - PoE options available on request.These fixtures are rated for Damp Location. IC Rated. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2015/863. Consult factory for tailored lighting options. Finelite makes the specification process easy when putting healthier products on your projects. Simply add – **RLA** (Red List Approved) or – **RLD** (Declared Label) to your part number.

WEIGHT[7]: R - 2.8 lb/ft; WW-R - 2.9 lb/ft

DLC QUALIFIED: Configurations of this product are listed on the DLC Qualified Products List (QPL). www.designlights.org/search

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

[5] Consult Finelite for Generator Transfer Device and Battery Backup fit
[6] 20 business days lead time for color
[7] Excludes Battery Backup and Generator Transfer Device weight

Submitted by:		Date:
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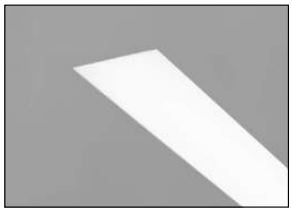
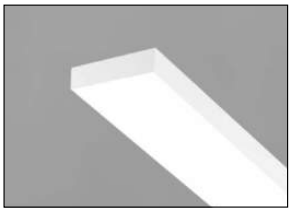
High Performance 4" Aperture (HP-4) Recessed L8B

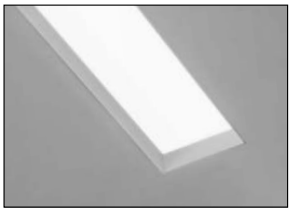
AESTHETIC OPTIONS



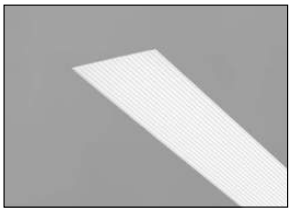
Flush Diffuser (**F**)



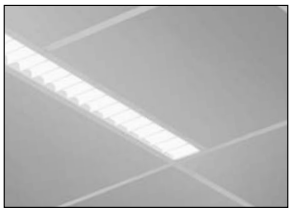
1" Drop Down Lens (**DL**)



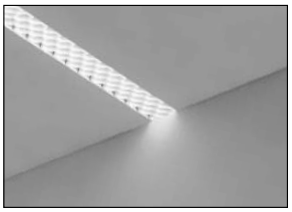
Flat Diffuser with 1" Regressed (**RG-D**)



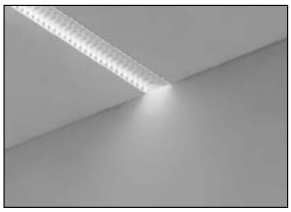
Downlight Spread Optic (**DSO**)
Externally flush



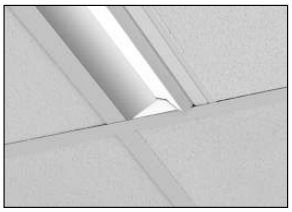
White Cross Blade Baffle[1] (**RG-WCB**)



Hex Louver[1] (**RG-LHC**)



Hollowed Ellipse Louver[1] (**RG-LHE**)



Kicker (**K**) - Wall Wash only

[1] Regressed only

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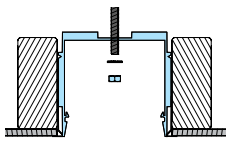
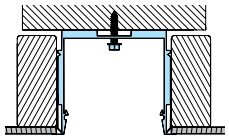
High Performance 4" Aperture (HP-4) Recessed L8B

HARD CEILING MOUNTING OPTIONS

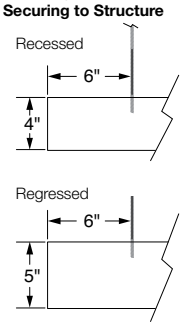
Threaded Rod Option



Screw Mount Option

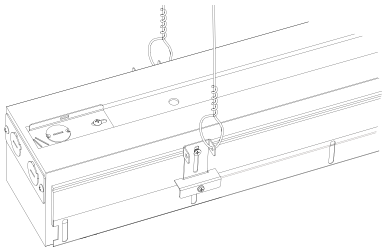


Mounting Location for Securing to Structure



Two mounting options: threaded rod and screw mounting options. Mounting locations are located on each end of the luminaire. Mounting location is 6" away from each end of luminaire.

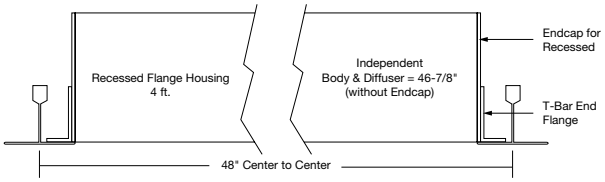
T-BAR INSTALLATION



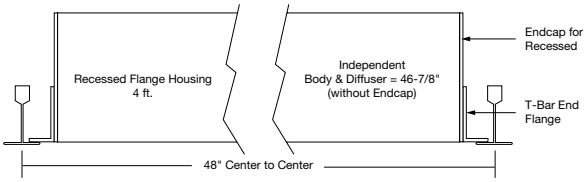
HP-4 R for T-Bar installations comes standard with a splice plate at the end of the luminaire. Mounting brackets (supplied) secure the luminaire to T-Bar and provide support to structure location. All even foot length (2, 4, 6, ...) luminaire runs are reduced in length by an appropriate amount to fit within typical 2x2 and 2x4 T-Bar grid systems. For uncommon T-Bar systems please consult factory.

GRID LENGTH DETAIL - 4' EXAMPLE

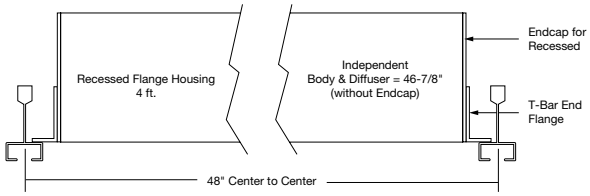
1" T-Bar



9/16" T-Bar

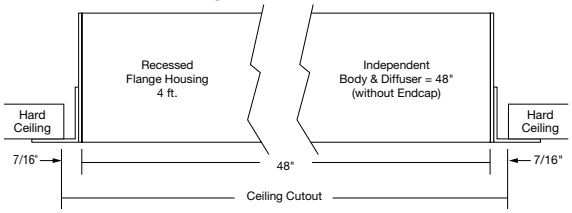


9/16" Screw Slot

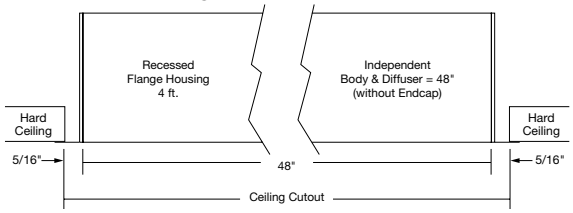


HARD CEILING LENGTH DETAIL - 4' EXAMPLE

Spackle Flange



Visible Flange



Submitted by:		Date:
Type:	Project:	
Ordering Info:		

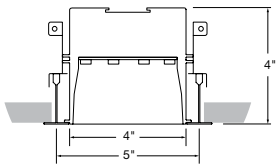
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

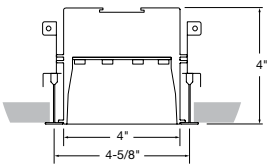
High Performance 4" Aperture (HP-4) Recessed L8B

RECESSED MOUNTING TYPES - T-BAR

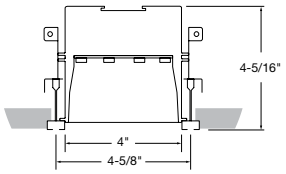
Rough-In Dimensions



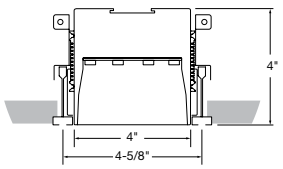
1" T-Bar (C1)



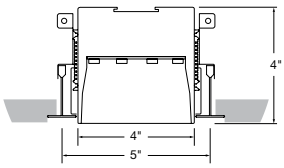
9/16" T-Bar (C2)



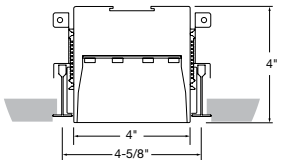
Standard Screw Slot (C3)



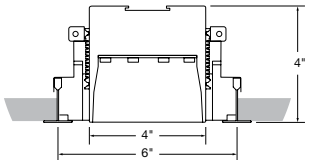
Flush Screw Slot (C3F)



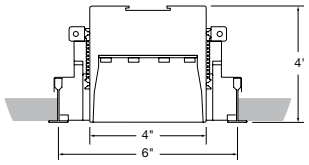
1" Tegular (C1T)



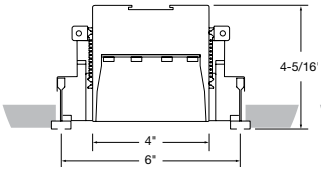
9/16" Tegular (C2T)



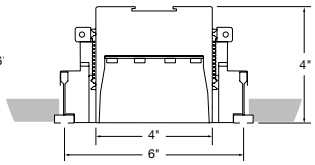
Tech Zone 6" (TZ6)
1" T-Bar (C1)



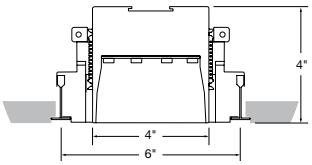
Tech Zone 6" (TZ6)
9/16" T-Bar (C2)



Tech Zone 6" (TZ6)
Standard Screw Slot (C3)

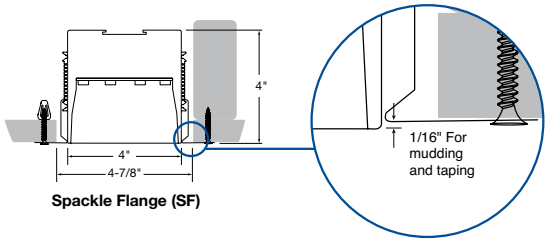


Tech Zone 6" (TZ6)
Flush Screw Slot (C3F)

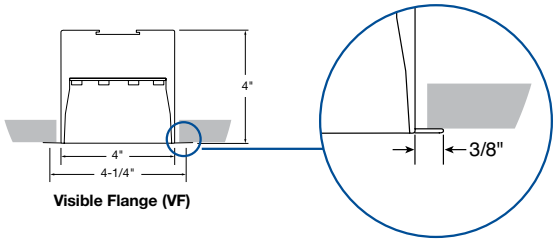


Tech Zone 6" (TZ6)
9/16" Tegular (C2T)

RECESSED MOUNTING TYPES - CUTOUT DIMENSIONS



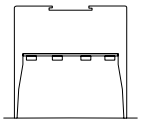
Spackle Flange (SF)



Visible Flange (VF)

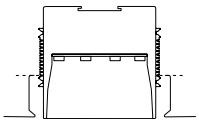
HOUSING

Version 1



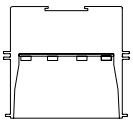
Ceiling Option VF

Version 2



Ceiling Options
C1T, C2T, C3F, SF, TZ6

Version 3



Ceiling Options
C1, C2, C3

Note: +/- 1/16"

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

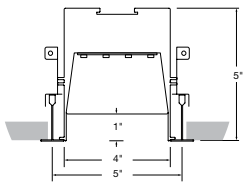
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE®
Better Lighting

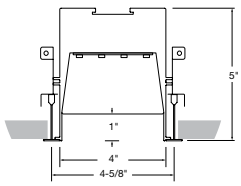
High Performance 4" Aperture (HP-4) Recessed L8B

REGRESSED MOUNTING TYPES - T-BAR

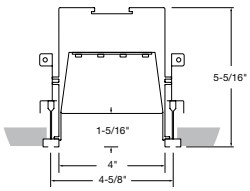
Rough-In Dimensions



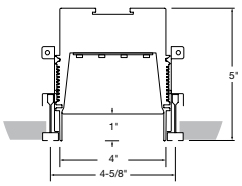
1" T-Bar (C1)



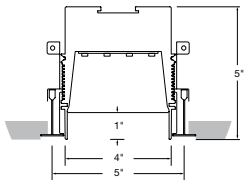
9/16" T-Bar (C2)



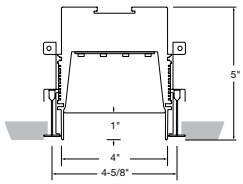
Standard Screw Slot (C3)



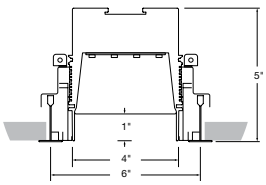
Flush Screw Slot (C3F)



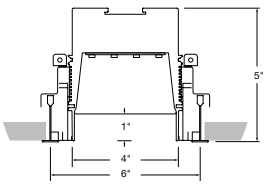
1" Tegular (C1T)



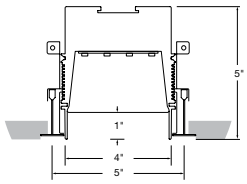
9/16" Tegular (C2T)



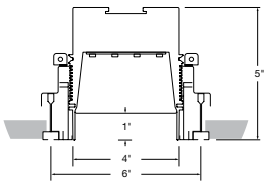
Tech Zone 6" (TZ6)
1" T-Bar (C1)



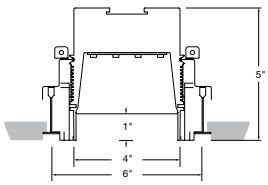
Tech Zone 6" (TZ6)
9/16" T-Bar (C2)



Tech Zone 6" (TZ6)
Standard Screw Slot (C3)

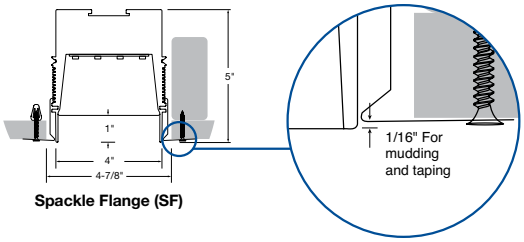


Tech Zone 6" (TZ6)
Flush Screw Slot (C3F)

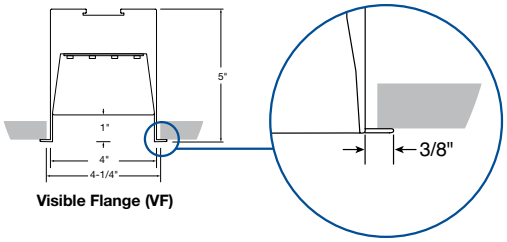


Tech Zone 6" (TZ6)
9/16" Tegular (C2T)

REGRESSED MOUNTING TYPES - CUTOUT DIMENSIONS



Spackle Flange (SF)

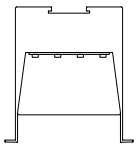


Visible Flange (VF)

Regressed Lens: Regressed lens version is 5" tall with a lens that is regressed 1" from ceiling line.

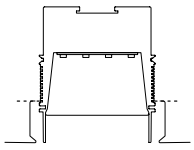
HOUSING

Version 1



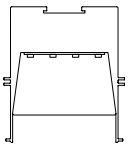
Ceiling Option VF

Version 2



Ceiling Options
C1T, C2T, C3F, SF, TZ6

Version 3



Ceiling Options
C1, C2, C3

Note: +/- 1/16"

Submitted by:	Date:
Type:	Project:
Ordering Info:	

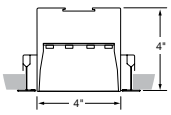
BUY AMERICAN ACT OF 2009 COMPLIANT

FINELITE® Better Lighting

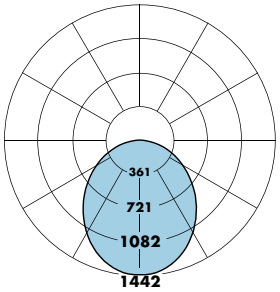
High Performance 4" Aperture (HP-4) Recessed L8B

Recessed Photometry - 4' Luminaire 3500K

HP4-R-D-4'-V-835
Downlight: Flush Diffuser



Efficacy: 101 lm/W
Total luminaire output: 3726 lumens (932 lm/ft)
37 watts (9.3 W/ft)
Peak Candela Value: 1442 @ 0°
CRI: 80 / CCT: 3500K
ITL LM79 Report 85128



CANDELA DISTRIBUTION

	0.0	22.5	45	67.5	90	Flux
0	1442	1442	1442	1442	1442	
5	1434	1434	1433	1433	1434	136
15	1369	1360	1365	1364	1359	384
25	1241	1226	1232	1225	1219	566
35	1064	1053	1055	1043	1037	657
45	864	853	851	840	834	655
55	650	644	640	631	626	571
65	441	436	433	428	425	428
75	238	237	238	237	236	252
85	70	69	70	72	71	78
90	0	0	0	0	0	

Complete LM79 LED Photometry

Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire			
S [1]	**B** [1]	**H** [1]	**V** [2]
1525	1917	2898	3726

Light Output, 3500K, 80 CRI (Lumens Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
381	479	725	932

Power, 3500K (Watts Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
3.6	4.6	7.1	9.3

Efficacy, 3500K, 80 CRI (Lumens Per Watt)			
S [1]	**B** [1]	**H** [1]	**V** [2]
105	104	102	101

Sample Lumen Adjustment Calculation

Lumen Adjustment Factors 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

Lumen Adjustment Factors 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

High Output (**H**), 4000K, 90 CRI

Lumen Adjustment Factor: 0.789

Total Light Output: 2898 lm x 0.789 = 2287 lm

Total Light Output per Foot: 725 lm/ft x 0.789 = 572 lm/ft.

watts/foot: 7.1 W/ft.

$$\textbf{Efficacy} = \frac{572\ \frac{\text{lm}}{\text{ft.}}}{7.1\ \frac{\text{W}}{\text{ft.}}} = 80\ \text{lm/W}$$

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output

[1] Family Correlation based on 4' luminaire 3500K Very High Output (**V**) test - 120V.
[2] Based on ITL report: 85128

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L9A

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T8 lengths. Ideal for use in commercial, retail, manufacturing, warehouse, and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate. Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.**

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install six-point row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), or matte black (MB). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications (see PLR_ ordering information on page 3). Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide 80CRI or 90 CRI at 3000 K, 3500 K, 4000 K or 5000 K.

Lumen output up to 1,500 lumens per foot. Luminaire should be installed in applications where ambient temperatures do not exceed 86 °F (30 °C).

INSTALLATION — Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Six-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40 °F (-40 °C) and 86 °F (30 °C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

BUY AMERICAN — Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Z SERIES

LED Striplight

ZL1D

24", 48" and 96" Lengths

Buy American

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 98
H+B

ZL1D LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1D L48 3000LM FST MVOLT 30K 80CRI WH

L9A

Series	Length	Reflectors[3]	Nominal lumens[4]	Diffuser	Voltage	Color temperature	Color rendering index
ZL1D LED striplight	L24 24" [2]	(blank) Less reflector	1500LM 1,500 lumens	FST Drop lens	MVOLT 120-277V	30K 3000 K	80CRI 80 CRI
		SMR Symmetric	2500LM 2,500 lumens		120 120V	35K 3500 K	90CRI 90 CRI
			3500LM 3,500 lumens		208 208V	40K 4000 K	
	L48 48"	(blank) Less reflector	3000LM 3,000 lumens		240 240V	50K 5000 K	
		ASR Asymmetric	5000LM 5,000 lumens		277 277V		
		SMR Symmetric	7000LM 7,000 lumens		347 347V [5]		
TZL1D LED striplight [1]	L96 96"	(blank) Less reflector	6000LM 6,000 lumens		480 480V [5]		
		SMR Symmetric	10000LM 10,000 lumens				
			14000LM 14,000 lumens				

Options

PLR__	Plug-in wiring[6,7]
PLR1LVG	Plug-in wiring-low voltage[6,7]
E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[8]
2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[8]
E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[8]
2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[8,9]
E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[8,9]
OUTEND	Cord set to exit endplate of fixture
BAA	Buy America(n) Act Compliant

Provide for EM lights only

Wireless Controls [6]

NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360°
NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360°, UL924 Emergency operation [10]

Individual Controls [6]

LBOZU	360° low mount motion sensor, pre-wired [11]
LBH0SZU	360° low mount motion sensor with dimming, pre-wired [11]
LBPZU	360° low mount motion sensor with photocell, pre-wired [11]
LBM0SZU	360° low mount motion sensor, dimming & switching photocell, pre-wired [11]

Cord sets: [12]

CS1W	Straight plug, 120V
CS3W	Twist-lock, 120V
CS7W	Straight plug, 277V
CS11W	Twist-lock, 277V
CS25W	Twist-lock, 347V
CS97W	Twist-lock, 480V
CS93W	600V SEOOW white cord, no plug (no voltage required)

Paint finish

WH	White
MB	Matte black
GALVB	Galvanized fixture with black plastic lens endcaps
GALVW	Galvanized fixture with white plastic lens endcaps

Accessories: *Order as separate catalog number.*

HC36 M12	Hanger chain, 36" (1 pair)
ZACVH M100	Adjustable 10' aircraft cable with Y hanger (1 pair)
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only
SQ_	Swivel stem hanger (specify length in 2" increments up to 48")
NPP16D	nLight® switching/dimming module
rPP20D	nLight® Air switching/dimming module
LSXR	Sensor Switch® LSXR occupancy sensor [5]
ZSPRG J2	Tong and T-grid hanger, for 15/16" T-grid (1 pair)
WGZ24	24" wireguard, white [13]
WGZ48	48" wireguard, white [13,14]
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish
ZLR L24 SYM WH	24" symmetric reflector, white finish
ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLR L46 SYM WH	46" symmetric reflector, white finish
ZLR L48 ASY WH	48" asymmetric reflector, white finish
ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
ZLR L48 SYM WH	48" symmetric reflector, white finish
ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZLR L92 SYM WH	92" symmetric reflector, white finish
ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
ZLR L96 SYM WH	96" symmetric reflector, white finish
UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Tandem fixture comes as two L46 or L48 fixtures
2 Not available with 347V, 480V or Batteries
3 Optional. Reflectors ship separately.
4 See Operational Data on page 2 for actual lumens.
5 Utilizes step down transformer.
6 See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
7 Not available with cord sets.
8 MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
9 Only available with 10,000LM and 14,000LM packages.
10 MVOLT only.
11 Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
12 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
13 Not compatible with reflector
14 Order 2 for tandem double length fixtures (TZL1N).

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 1-800-705-SERV (7378) www.lithonia.com techsupport-industrial@acuitybrands.com

OPERATIONAL DATA												
	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1985	1619	2030	1675	2061	1707	2137	1745	17	1-lamp 17W T8
	2500LM	24	2682	2187	2742	2264	2785	2307	2887	2358	22	1-lamp 17W T8
	3500LM	24	4099	3341	4190	3459	4255	3524	4412	3603	36	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	48	3880	3163	3966	3274	4028	3336	4176	3410	30	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	48	5337	4351	5456	4504	5541	4589	5745	4691	41	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	48	7317	5965	7480	6175	7596	6291	7876	6431	59	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	96	8077	6585	8257	6816	8386	6945	8694	7099	60	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	96	11021	8985	11267	9301	11442	9477	11864	9687	81	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	96	15397	12553	15741	12995	15986	13240	16574	13534	121	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID

PROJECTED LUMEN MAINTENANCE

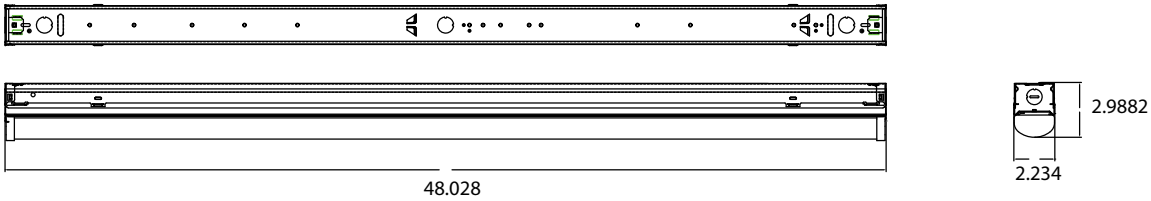
Operating Hours	0	15,000	30,000	45,000	60,000	100,000
Lumen Maintenance Factor	1	0.94	0.89	0.83	0.79	0.67

DIMENSIONS

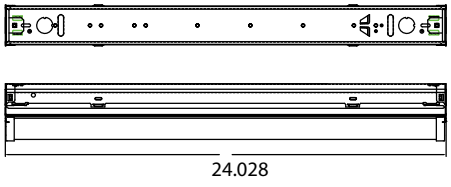
All dimensions are shown in inches (centimeters) unless otherwise noted.

Specifications subject to change without notice.

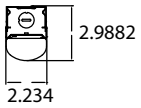
PALLET DIMENSIONS			
Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	176	46" X 51" X 31 5/8"
L48	13 lbs.	176	46" X 51" X 31 5/8"
L96	26 lbs.	63	46" X 98 1/2" X 31 3/8"



ZL1D L48

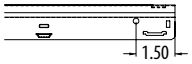


Knockout hole is .86in in diameter.



ZL1D L24

Mounting Hole Location - All Lengths



INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 1-800-705-SERV (7378) www.lithonia.com techsupport-industrial@acuitybrands.com

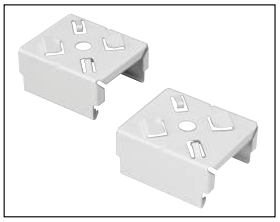
OPTIONS AND ACCESSORIES

The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN

36" chain with Y hanger.

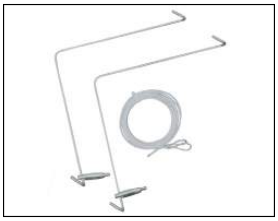
Order as:
HC36



Z SPRING HANGER L9A

Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

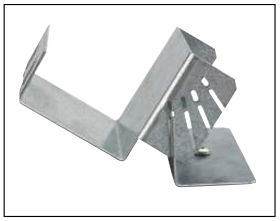
Order as:
ZSPRG



ZACVH HANGER

10' Aircraft cable with Y hanger.

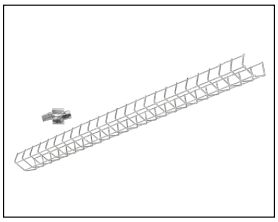
Order as:
ZACVH



ANGLE MOUNTING BRACKET

Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 1-800-705-SERV (7378) www.lithonia.com techsupport-industrial@acuitybrands.com

LITHONIA LIGHTING®

Catalog Number	L9B
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T8 lengths. Ideal for use in commercial, retail, manufacturing, warehouse, and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install six-point row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), or matte black (MB). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications (see PLR_ ordering information on page 3). Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide 80CRI or 90 CRI at 3000 K, 3500 K,4000 K or 5000 K.

Lumen output up to 1,500 lumens per foot. Luminaire should be installed in applications where ambient temperatures do not exceed 86 °F (30 °C).

INSTALLATION — Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Six-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40 °F (-40 °C) and 86 °F (30 °C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

BUY AMERICAN — Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

LED Striplight

ZL1D

24", 48" and 96" Lengths

Buy American

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

ZL1D LED Striplight

L9B

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1D L48 3000LM FST MVOLT 40K 80CRI WH

Series	Length	Reflectors[3]	Nominal lumens[4]	Diffuser	Voltage	Color temperature	Color rendering index
ZL1D LED striplight	L24 24" [2]	(blank) Less reflector	1500LM 1,500 lumens	FST Drop lens	MVOLT 120-277V	30K 3000 K	80CRI 80 CRI
		SMR Symmetric	2500LM 2,500 lumens		120 120V	35K 3500 K	90CRI 90 CRI
			3500LM 3,500 lumens		208 208V	40K 4000 K	
	L48 48"	(blank) Less reflector	3000LM 3,000 lumens		240 240V	50K 5000 K	
		ASR Asymmetric	5000LM 5,000 lumens		277 277V		
		SMR Symmetric	7000LM 7,000 lumens		347 347V [5]		
TZL1D LED striplight [1]	L96 96"	(blank) Less reflector	6000LM 6,000 lumens		480 480V [5]		
		SMR Symmetric	10000LM 10,000 lumens				
			14000LM 14,000 lumens				

Options

PLR__	Plug-in wiring[6,7]
PLR1LVG	Plug-in wiring-low voltage[6,7]
E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[8]
2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[8]
E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[8]
2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[8,9]
E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[8,9]
OUTEND	Cord set to exit endplate of fixture
BAA	Buy America(n) Act Compliant

Provide for EM lights only

Wireless Controls [6]

NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360°
NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360°, UL924 Emergency operation [10]

Individual Controls [6]

LBOZU	360° low mount motion sensor, pre-wired [11]
LBH0SZU	360° low mount motion sensor with dimming, pre-wired [11]
LBPZU	360° low mount motion sensor with photocell, pre-wired [11]
LBM0SZU	360° low mount motion sensor, dimming & switching photocell, pre-wired [11]

Cord sets: [12]

CS1W	Straight plug, 120V
CS3W	Twist-lock, 120V
CS7W	Straight plug, 277V
CS11W	Twist-lock, 277V
CS25W	Twist-lock, 347V
CS97W	Twist-lock, 480V
CS93W	600V SEOOW white cord, no plug (no voltage required)

Paint finish

WH	White
MB	Matte black
GALVB	Galvanized fixture with black plastic lens endcaps
GALVW	Galvanized fixture with white plastic lens endcaps

Accessories: *Order as separate catalog number.*

~~HC36 M12~~	~~Hanger chain, 36" (1 pair)~~
ZACVH M100	Adjustable 10' aircraft cable with Y hanger (1 pair)
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only
SQ_	Swivel stem hanger (specify length in 2" increments up to 48")
NPP16D	nLight® switching/dimming module
rPP20D	nLight® Air switching/dimming module
LSXR	Sensor Switch® LSXR occupancy sensor [5]
ZSPRG J2	Tong and T-grid hanger, for 15/16" T-grid (1 pair)
WGZ24	24" wireguard, white [13]
WGZ48	48" wireguard, white [13,14]
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish
ZLR L24 SYM WH	24" symmetric reflector, white finish
ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLR L46 SYM WH	46" symmetric reflector, white finish
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ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
ZLR L48 SYM WH	48" symmetric reflector, white finish
ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZLR L92 SYM WH	92" symmetric reflector, white finish
ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
ZLR L96 SYM WH	96" symmetric reflector, white finish
UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1. Tandem fixture comes as two L46 or L48 fixtures
2. Not available with 347V, 480V or Batteries
3. Optional. Reflectors ship separately.
4. See Operational Data on page 2 for actual lumens.
5. Utilizes step down transformer.
6. See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
7. Not available with cord sets.
8. MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
9. Only available with 10,000LM and 14,000LM packages.
10. MVOLT only.
11. Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
12. Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
13. Not compatible with reflector
14. Order 2 for tandem double length fixtures (TZL1N).

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 1-800-705-SERV (7378) www.lithonia.com techsupport-industrial@acuitybrands.com

OPERATIONAL DATA

	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
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	3000LM	48	3880	3163	3966	3274	4028	3336	4176	3410	30	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
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	10000LM	96	11021	8985	11267	9301	11442	9477	11864	9687	81	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	96	15397	12553	15741	12995	15986	13240	16574	13534	121	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID

PROJECTED LUMEN MAINTENANCE

Operating Hours	0	15,000	30,000	45,000	60,000	100,000
Lumen Maintenance Factor	1	0.94	0.89	0.83	0.79	0.67

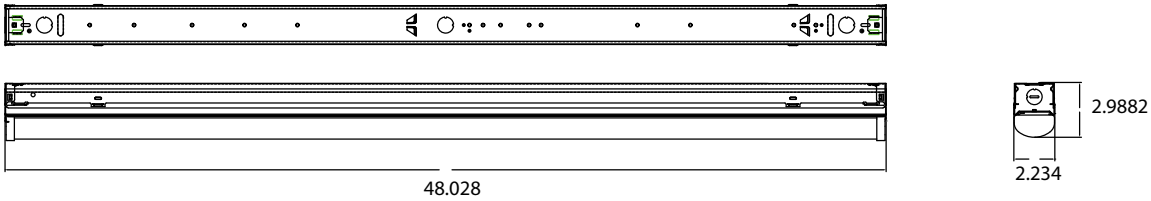
DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.

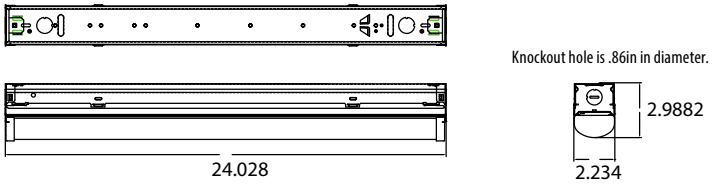
Specifications subject to change without notice.

PALLET DIMENSIONS

Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	176	46" X 51" X 31 5/8"
L48	13 lbs.	176	46" X 51" X 31 5/8"
L96	26 lbs.	63	46" X 98 1/2" X 31 3/8"

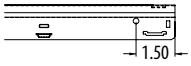


ZL1D L48



ZL1D L24

Mounting Hole Location - All Lengths



INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 1-800-705-SERV (7378) www.lithonia.com techsupport-industrial@acuitybrands.com

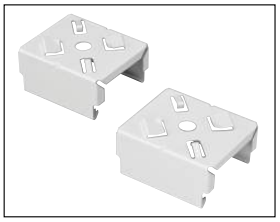
OPTIONS AND ACCESSORIES

The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN

36" chain with Y hanger.

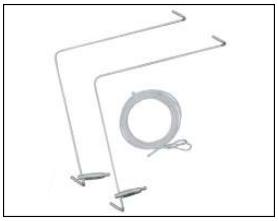
Order as:
HC36



Z SPRING HANGER

Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

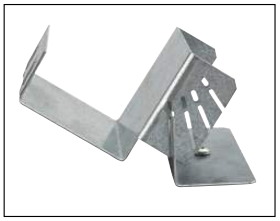
Order as:
ZSPRG



ZACVH HANGER

10' Aircraft cable with Y hanger.

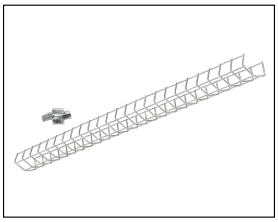
Order as:
ZACVH



ANGLE MOUNTING BRACKET

Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 1-800-705-SERV (7378) www.lithonia.com techsupport-industrial@acuitybrands.com

LITHONIA LIGHTING®

Catalog Number	L9C
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T8 lengths. Ideal for use in commercial, retail, manufacturing, warehouse, and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate. Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.**

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install six-point row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), or matte black (MB). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications (see PLR_ ordering information on page 3). Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide 80CRI or 90 CRI at 3000 K, 3500 K,4000 K or 5000 K.

Lumen output up to 1,500 lumens per foot. Luminaire should be installed in applications where ambient temperatures do not exceed 86 °F (30 °C).

INSTALLATION — Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Six-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40 °F (-40 °C) and 86 °F (30 °C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

BUY AMERICAN — Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Z SERIES

LED Striplight

ZL1D

24", 48" and 96" Lengths

Buy American

LIGHT FIXTURE REQUIRED TO BE DLC LISTED

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

ZL1D LED Striplight

L9C

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1D L48 3000LM FST MVOLT 40K 80CRI WH

Series	Length	Reflectors[3]	Nominal lumens[4]	Diffuser	Voltage	Color temperature	Color rendering index
ZL1D LED striplight	L24 24" [2]	(blank) Less reflector	1500LM 1,500 lumens	FST Drop lens	MVOLT 120-277V	30K 3000 K	80CRI 80 CRI
		SMR Symmetric	2500LM 2,500 lumens		120 120V	35K 3500 K	90CRI 90 CRI
			3500LM 3,500 lumens		208 208V	40K 4000 K	
	L48 48"	(blank) Less reflector	3000LM 3,000 lumens		240 240V	50K 5000 K	
		ASR Asymmetric	5000LM 5,000 lumens		277 277V		
		SMR Symmetric	7000LM 7,000 lumens		347 347V [5]		
TZL1D LED striplight [1]	L96 96"	(blank) Less reflector	6000LM 6,000 lumens		480 480V [5]		
		SMR Symmetric	10000LM 10,000 lumens				
			14000LM 14,000 lumens				

Options

PLR__	Plug-in wiring[6,7]
PLR1LVG	Plug-in wiring-low voltage[6,7]
E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[8]
2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[8]
E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[8]
2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[8,9]
E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[8,9]
OUTEND	Cord set to exit endplate of fixture
BAA	Buy America(n) Act Compliant

Provide for EM lights only

Wireless Controls [6]

NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360°
NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360°, UL924 Emergency operation [10]

Individual Controls [6]

LBOZU	360° low mount motion sensor, pre-wired [11]
LBH0SZU	360° low mount motion sensor with dimming, pre-wired [11]
LBPZU	360° low mount motion sensor with photocell, pre-wired [11]
LBM0SZU	360° low mount motion sensor, dimming & switching photocell, pre-wired [11]

Cord sets: [12]

CS1W	Straight plug, 120V
CS3W	Twist-lock, 120V
CS7W	Straight plug, 277V
CS11W	Twist-lock, 277V
CS25W	Twist-lock, 347V
CS97W	Twist-lock, 480V
CS93W	600V SEOOW white cord, no plug (no voltage required)

Paint finish

WH	White
MB	Matte black
GALVB	Galvanized fixture with black plastic lens endcaps
GALVW	Galvanized fixture with white plastic lens endcaps

Accessories: *Order as separate catalog number.*

HC36 M12	Hanger chain, 36" (1 pair)
ZACVH M100	Adjustable 10' aircraft cable with Y hanger (1 pair)
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only
SQ_	Swivel stem hanger (specify length in 2" increments up to 48")
NPP16D	nLight® switching/dimming module
rPP20D	nLight® Air switching/dimming module
LSXR	Sensor Switch® LSXR occupancy sensor [5]
ZSPRG J2	Tong and T-grid hanger, for 15/16" T-grid (1 pair)
WGZ24	24" wireguard, white [13]
WGZ48	48" wireguard, white [13,14]
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish
ZLR L24 SYM WH	24" symmetric reflector, white finish
ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLR L46 SYM WH	46" symmetric reflector, white finish
ZLR L48 ASY WH	48" asymmetric reflector, white finish
ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
ZLR L48 SYM WH	48" symmetric reflector, white finish
ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZLR L92 SYM WH	92" symmetric reflector, white finish
ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
ZLR L96 SYM WH	96" symmetric reflector, white finish
UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Tandem fixture comes as two L46 or L48 fixtures
2 Not available with 347V, 480V or Batteries
3 Optional. Reflectors ship separately.
4 See Operational Data on page 2 for actual lumens.
5 Utilizes step down transformer.
6 See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
7 Not available with cord sets.
8 MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
9 Only available with 10,000LM and 14,000LM packages.
10 MVOLT only.
11 Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
12 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
13 Not compatible with reflector
14 Order 2 for tandem double length fixtures (TZL1N).

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OPERATIONAL DATA												
	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1985	1619	2030	1675	2061	1707	2137	1745	17	1-lamp 17W T8
	2500LM	24	2682	2187	2742	2264	2785	2307	2887	2358	22	1-lamp 17W T8
	3500LM	24	4099	3341	4190	3459	4255	3524	4412	3603	36	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	48	3880	3163	3966	3274	4028	3336	4176	3410	30	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	48	5337	4351	5456	4504	5541	4589	5745	4691	41	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	48	7317	5965	7480	6175	7596	6291	7876	6431	59	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	96	8077	6585	8257	6816	8386	6945	8694	7099	60	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	96	11021	8985	11267	9301	11442	9477	11864	9687	81	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	96	15397	12553	15741	12995	15986	13240	16574	13534	121	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID

PROJECTED LUMEN MAINTENANCE

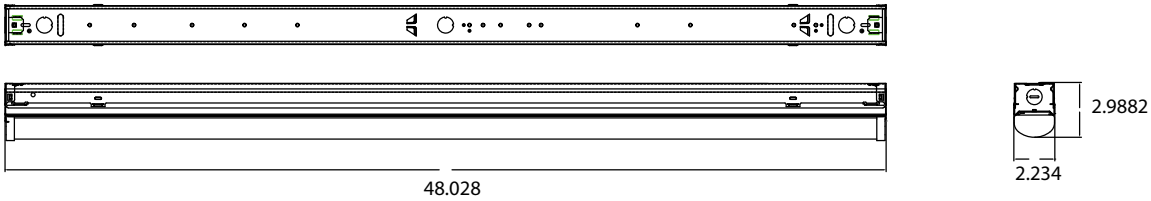
Operating Hours	0	15,000	30,000	45,000	60,000	100,000
Lumen Maintenance Factor	1	0.94	0.89	0.83	0.79	0.67

DIMENSIONS

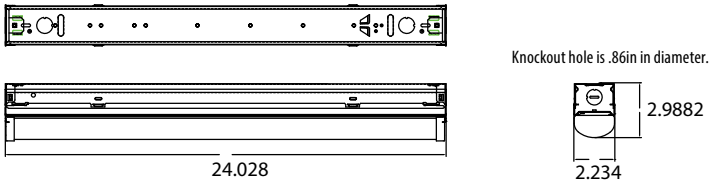
All dimensions are shown in inches (centimeters) unless otherwise noted.

Specifications subject to change without notice.

PALLET DIMENSIONS			
Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	176	46" X 51" X 31 5/8"
L48	13 lbs.	176	46" X 51" X 31 5/8"
L96	26 lbs.	63	46" X 98 1/2" X 31 3/8"



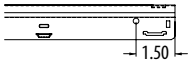
ZL1D L48



Knockout hole is .86in in diameter.

ZL1D L24

Mounting Hole Location - All Lengths



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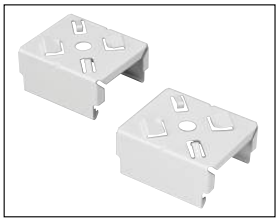
OPTIONS AND ACCESSORIES

The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN

36" chain with Y hanger.

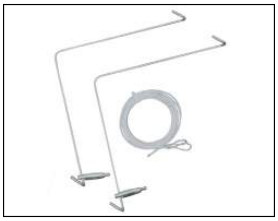
Order as:
HC36



Z SPRING HANGER

Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

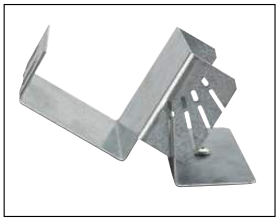
Order as:
ZSPRG



ZACVH HANGER

10' Aircraft cable with Y hanger.

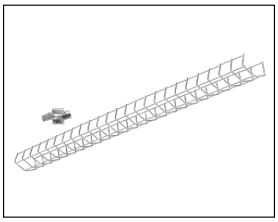
Order as:
ZACVH



ANGLE MOUNTING BRACKET

Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

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Pru15 | Linear

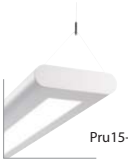
Approved Alternate Manufacturers:
Finelite Series 16 LED Indirect/Direct

PRUDENTIAL LTG.
PRULITE.COM 213.746.0360

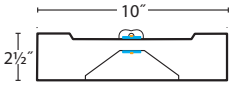
Type: L10

Job:

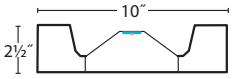
Pru15-SQ



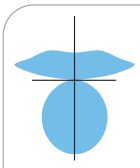
Pru15-R



D3 - 2 row of LEDs
Configurable Down/Up



D9 - 1 row of LEDs
17 Up, 83 Down



PRU15-LED4-LO-SAL-D3

3202	Delivered Lumens
34.1	Watts
94	lm/w

UP TO **106** LM/W

D3 — at 53% Uplight, 47% Down (LO/LO, etc.)

	LO	MO	SO	HO
lm/ft	725	975	1300	1700
w/ft	7	9.3	13	17

D1 — Down only

lm/ft	340	465	600	750
w/ft	3.5	4.6	7	10

D9 — 17 Up, 83 Down

lm/ft	365	500	720	935
w/ft	3.5	4.6	7	10

CLICK HERE

WA: .05 LLF when using SAL IES

Control down and uplight separately.

Control the amount of Down vs. Up light separately by specifying different outputs (eg. LO Down/HO Up) and/or Dual Circuit (DC) dimming controls; 20 down/80 up, 80 down/20 up or anywhere in between is easily attained. Control down and uplight separately with DC, turning off the Down and leaving the Up dimmed for projector usage. It's all about control.

HO for direct, LO for indirect

Made in the USA

LED Details

Lumen output may vary +/- 5%
4000K used for lm/ft estimates above
3500K –2% llf, 3000K –4%, 2700K –6%
-10% LLF for 90 CRI (4K, 3500K and 3K)

See LED Details PDF for more info

SERIES	STYLE	LED COLOR	OUTPUT	NOMINAL LENGTH	SHIELDING	COLOR/ FINISH	DISTRIBUTION	CIRCUITING	VOLTAGE	MOUNTING	CEILING SYSTEMS	DRIVERS	OPTIONS & SENSORS
PRU15	SQ Square R Round	LED27 2700K (90CRI) LED3 3000K LED35 3500K LED4 4000K LED3-90 90CRI LED35-90 90CRI LED4-90 90CRI	– LO Low MO Medium SO Standard HO High PROG Programmable Light Output (Specify desired lm/ft or w/ft) **NOTE for D3:** Specify separate output Down / Up if desired eg. HO/LO.	4′ 8′ R___ (Row Length in 4′ increments only) **NOTES:** Individual fixtures are NOT intended for row mounting Row lengths are typically made up of 8′ and 4′ fixtures (8′ come standard in long rows) unless symmetric row lengths are requested.	SAL Satin Acrylic Lens WA White Acrylic Lens (Standard) **WA: .05 LLF when using SAL IES**	TMW Textured Matte White (Standard) YSW Seashell White (Matte) (Premium color) Y__ Premium Color CC Custom Color **NOTE:** All canopies are painted the same color as the fixture. Consult factory to specify	D3 Direct/ Indirect **NOTE:** (Adjustable down/up if DC is specified) D1 Direct Solid Top **NOTE:** Only 1 row of LEDs. D9 Semi-Direct **NOTE:** Only 1 row of LEDs, 83% Down, 17% Up.	SC Single Circuit DC Dual Circuit (Two feeds required, Control Down & Up Light Separately, D3 only)	UNV (120-277) 347 (Emergency battery requires a Step Down transformer)	CA48″, 96″ or 144″ Aircraft Cable (Adjustable)	X1 T-Bar 15/16″ or 9/16″ Exposed (Standard) (Consult factory for 9/16″ Tegular X3 Hard Ceiling X6 Slot Grid or Interlude	ND Non-Dimming DM01 0-10v, 1% Dimming (Standard) LDE5 Lutron 5-Series EcoSystem LED LDE1 Lutron Hi-lume 1% EcoSystem LED (Soft fade on, fade-to-black dimming) ECO 1% 0-10v, EldoLED (Logarithmic dimming std) ECDA 1% DALI, EldoLED (Logarithmic dimming std) SOLO 0.1% 0-10v, EldoLED (Dim-to-dark, Logarithmic dimming std) SODA 0.1% DALI, EldoLED (Dim-to-dark, Logarithmic dimming std) AS INDICATED ON PLAN	EMHE CA T20 Emergency Battery (1100 delivered lumens; CA Title 20 compliant) PRUBIN Meticulous Binning and Labeling every LED Board within a 2-Step MacAdams Ellipse **SENSORS:** 205-ON/OFF WattStopper PIR Occupancy **205-STEP:** Dim to 50% **205-DM:** Dim to 1% LUX Phillips DLH

Linear

03-26-2021

Pru15 | Linear

PRUDENTIAL LTG.

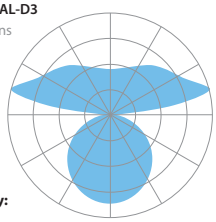
PRULITE.COM 213.746.0360

L10

D3 — SPECIFY DOWN/UP SEPARATELY

Medium Down / Medium Up:
PRU15-LED4-MO-MO-SAL-D3

3940	Delivered Lumens
37	Watts
106	lm/w
4000	CCT
Test	#L021502301



688

Zonal Lumen Summary:
0-90 (Down)= 51%
90-180 (UP) = 49%

Vertical Angle	0°	25°	45°	65°	90°
0°	688	688	688	688	688
5°	682	683	685	684	684
15°	648	649	652	651	651
25°	586	588	590	591	589
35°	505	505	508	508	508
45°	408	411	414	415	416
55°	307	311	315	317	318
65°	211	216	223	227	229
75°	113	120	130	138	141
85°	38	43	58	68	73
90°	13	25	46	53	52
95°	22	57	247	298	176
105°	66	109	267	623	841
115°	119	169	258	497	653
125°	176	233	316	493	605
135°	231	284	359	483	567
145°	275	314	376	444	492
155°	318	338	377	412	429
165°	351	359	374	388	397
175°	370	371	374	374	376
180°	373	373	373	373	373

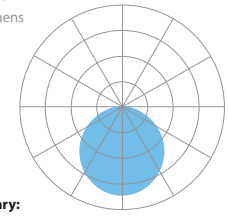
D3 Distribution Options – DOWN and UP

	LO/LO	LO/MO	LO/SO	LO/HO
Lm/ft	340/385	340/520	340/690	340/850
w/ft % DWN/ UP	7 52/48	8.2 45/55	10 39/61	12 34/66
	MO/LO	**MO/MO**	**MO/SO**	**MO/HO**
Lm/ ft w/ ft %	460/385 8.2 60/40	460/520 9.3 53/47	690/460 11.2 46/54	460/850 13.2 41/59
	SO/LO	**SO/MO**	**SO/SO**	**SO/HO**
Lm/ ft w/ ft %	610/385 10 67/33	615/520 11.2 60/40	610/690 13 53/47	610/850 15 48/52
	HO/LO	**HO/MO**	**HO/SO**	**HO/HO**
Lm/ ft w/ ft %	750/385 12 71/29	750/520 13.2 58/42	750/690 15 58/42	750/850 17 53/47

D1 — DOWNLIGHT ONLY

Standard Output:
PRU15-LED4-SO-SAL-D1

2434	Delivered Lumens
26	Watts
94	lm/w
4000	CCT
Test	#L031506601



901

Zonal Lumen Summary:
0-90 (Down) = 100%

Vertical Angle	0°	25°	45	65°	90°
0°	901	901	901	901	901
5°	894	895	897	897	896
15°	849	850	854	856	852
25°	768	771	773	774	772
35°	661	662	666	666	666
45°	535	538	542	543	545
55°	402	408	412	415	416
65°	277	283	291	297	299
75°	148	157	167	180	185
85°	42	56	75	90	95
90°	17	33	60	69	69

Luminance Chart:

Angle	0°	45°	90°
45°	6368	5136	4817
55°	5833	4388	4052
65°	5341	3664	3357
75°	4446	2712	2530
85°	3107	1716	1746

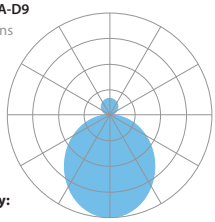
UP TO 94 LM/W

	LO	MO	SO	HO
lm/ft	360	465	600	750
w/ft	3.25	4.6	6.5	8.25

D9 (ONE ROW OF LEDS)

High Up / Low Down:
PRU15-LED4-MO-04-WA-D9

1626	Delivered Lumens
17.2	Watts
94	lm/w
4000	CCT
Test	#L0101404401



518

Zonal Lumen Summary:
0-90 (Down) = 84%
90-180 (Up) = 16%

Vertical Angle	0°	25°	45°	65°	90°
0°	518	518	518	518	518
5°	514	514	515	514	514
15°	490	490	490	489	488
25°	447	447	445	442	440
35°	389	388	384	379	376
45°	321	319	313	308	306
55°	246	243	238	233	231
65°	168	166	162	158	157
75°	87	85	83	81	80
85°	22	22	20	19	18
90°	0	0	0	0	0
95°	9	10	9	8	7
105°	21	25	29	28	13
115°	34	33	39	44	46
125°	46	44	47	50	52
135°	58	55	56	57	58
145°	67	61	65	65	65
155°	75	74	73	73	72
165°	81	80	80	79	79
175°	83	84	84	84	84
180°	84	84	84	84	84

18-719
12/07/21
Bids

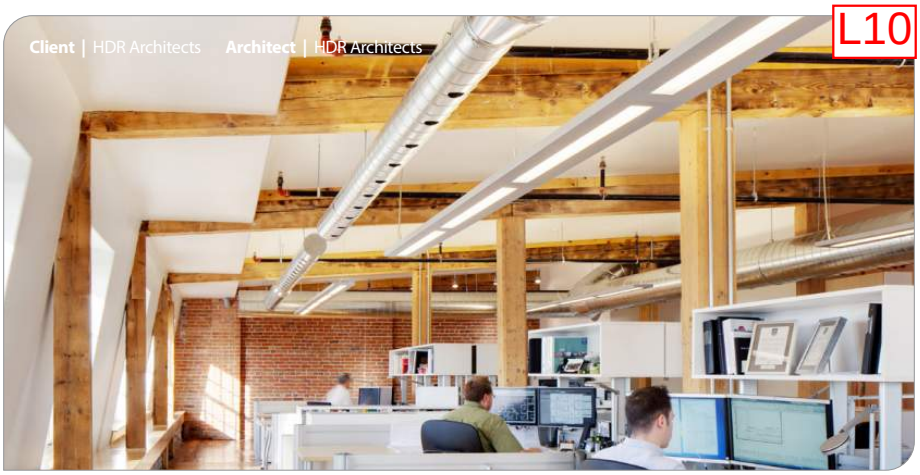
Luminaire Product Data
26 5700 - 111
H+B

Pru15 | Linear

PRUDENTIAL LTG.

PRULITE.COM 213.746.0360

L10



LUMEN MAINTENANCE

Designed to last with cool running mid-power LEDs projected to maintain 90% (L90) of their initial output for 100,000 hours (at HO), and L70 exceeding 150,000 hours.

LED SYSTEM — LED modules and drivers are field replaceable.

PROG (OPTIONAL) — Programmable light output. Specify desired lumens or watts per linear foot. Min: 2½ w/ft, consult factory for requests above 12 w/ft.

BINNING — Standard binning (all Prudential LED boards) includes testing at the chip level and board integration to provide consistent color temperature within a 3-step MacAdams ellipse, with +/- 5% lumen output range and +/- .004 Duv.

PRUBIN™ (OPTIONAL) — Prudential Ltg's exclusive 'job binning' method that ensures color temperature consistency across all luminaires on a project. Meticulously testing and labeling **EVERY LED BOARD** to +/- 25 lumens, +/- 50k CCT and +/- .004 Duv — while also separating positive from negative — allows us to match color, hue and intensity throughout a project and provides a consistent color temperature within a 2-step MacAdams ellipse.

LABELS — CSA and ETL damp labeled and I.B.E.W. manufactured.

ELECTRICAL — Must specify LED dimming controls. LED fixtures have constant current driver(s) with less than 20% THD when loaded to a minimum of 60%. Drivers sink a maximum of 6mA per driver. DM01 LED drivers are 0-10V dimmable and are compatible with most 0-10V wall slide dimmers and direct 0-10V analog signal dimmers. Max driver size 1¼˝ w x 1˝ h.

CONSTRUCTION

Power cord is White except for fixtures painted Black. (YBB, YBK) have Black power cords.

Housing	20-gauge steel, >20% PC recycled, 100% recyclable, PAF, Painted After Fabrication
Lens	Acrylic, 100% recyclable.
Weight	6 lbs / ft.

MOUNTING — Suspended by adjustable cable.

WARRANTY — Single-source, 5 year limited warranty covers standard components and construction.

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 112
H+B

LED Pru15 | Linear

PRUDENTIAL LTG.

PRULITE.COM 213.746.0360

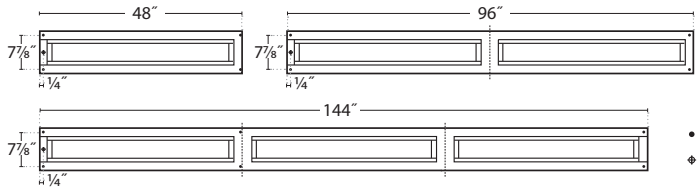
L10

YSW – Seashell White (Matte)
YCH – Champagne (Metallic)
YSL – Silver (Metallic)
YPE – Pewter (Matte)
YRG – Rain Grey (Gloss)
YSTM – Storm Grey (Matte)
YBK – Black (Matte)
YBB – Black (Semi Gloss)
YSKM – Sky (Matte)
YMB – Military Blue (Matte)
YIB – Interstate Blue (Matte)
YSAM – Sapphire (Matte)
YFGM – Forest Green (Matte)
YBR – Bronze (Matte)
YBY – Boysenberry (Matte)
YSRM – Sunset Red (Matte)
YOR – Orange (Matte)
YDAM – Daffodil (Matte)

Choose from one of our Premium Colors with no set-up fee.

For paint chip samples, please email:
info@prulite.com

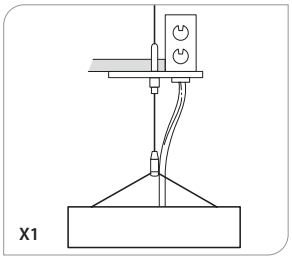
MOUNTING LOCATIONS

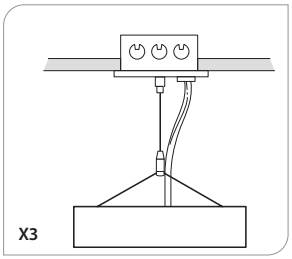


- Cable Mount
- ⅞″ Wiring K.O.

NOTE: When connecting two or more, only one mounting assembly required on each additional fixture.

CEILING SYSTEMS





CONTROLS

205: WattStopper PIR Occupancy

LUX: Phillips LuxSense Daylight Harvesting, used with Phillips HFR Driver

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 113
H+B

Invue

DESCRIPTION

The Entri LED luminaire features a classic and stylish design with the added benefits of solid state lighting technology, offering outstanding uniformity and energy savings. Using Cooper Lighting Solutions' proprietary LED LightSquare technology and AccuLED Optics™ system, the Entri LED luminaire offers designers vast versatility in system design, function and performance. Use Entri LED for wall mount architectural lighting applications and egress lighting requirements. UL/cUL listed for use in wet locations.

Catalog #		Type	L11
Project			
Comments		Date	
Prepared by	NO EQUALS WILL BE ACCEPTED CAMPUS STANDARD FIXTURE		

SPECIFICATION FEATURES

Construction
HOUSING: Heavy wall, one-piece, die-cast aluminum construction for precise tolerance control and repeatability in manufacturing. Integral extruded aluminum heat sink provides superior thermal heat transfer in +40°C ambient environments. FACEPLATE / DOOR: One-piece, die-cast aluminum construction. Captive, side hinged faceplate swings open via release of one flush mount die-cast aluminum latch on housing side panel. GASKET: One-piece molded silicone gasket mates perfectly between the door and housing for repeatable seal. LENS: Uplight lens is impact-resistant, 5/32″ thick tempered frosted glass sealed to housing with continuous bead silicone gasket. Downlight lens is an LED LightSquare with integral optics sealed for IP66 rating. HARDWARE: Stainless steel mounting screws and latch hardware allow access to electrical components for installation and servicing.

Optics
Choice of 9 patented, high efficiency AccuLED Optics™ distributions. Optics are precisely designed to shape the light output, maximizing efficiency and application spacing. AccuLED Optics technology creates consistent distributions with the scalability to meet customized application requirements. CRI and CCT offering includes 2200K, 2700K, 3000K, 3500K, 4000K, 5000K, and 5700K with minimum 70CRI and 2700K and 3000K with minimum 80CRI all within 5-step MacAdam ellipse.

Electrical
LED drivers mount to die-cast aluminum back housing for optimal heat sinking, operation efficacy, and prolonged life. Standard drivers feature electronic universal voltage (120-277V 50/60Hz), 347V 60Hz or 480V 60Hz operation. 480V is compatible for use with 480V Wye systems only. Greater than 0.9 power factor, less than 20% harmonic distortion, and is suitable for operation in -40°C to 40°C ambient environments and optional 50C construction available. All fixtures are shipped standard with 10kV/10kA common – and differential – mode surge protection. LightSquare feature an IP66 enclosure rating and maintain greater than 98% lumen maintenance at 60,000 hours per IESNA TM-21. Emergency egress options for -20°C ambient environments, WaveLinx™, occupancy sensor, and dimming options available.

Mounting
JUNCTION BOX: Standard with zinc-plated, quick-mount junction box plate that mounts directly to 4″ J-Box. LightSquare mounts facing downward. Fixture slides over mounting plate and is secured with two stainless steel fasteners. Mounting plate features a one-piece EPDM gasket on back side of plate to firmly seal fixture to wall surface, forbidding entry of moisture and particulates. Optional mounting arrangements utilize a die-cast mounting adaptor box to allow for LED battery pack, surface conduit and trough branch wiring. The Entri LED luminaire is approved for mounting on combustible surfaces.

Finish
Housing is finished in five-stage super TGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear. LightSquare cover plates are standard white and may be specified to match finish of luminaire housing. Standard colors include black, bronze, grey, white, dark platinum and graphite metallic. RAL and custom color matches available. Consult Outdoor Architectural Colors brochure for a complete selection.

Warranty
Five-year warranty.

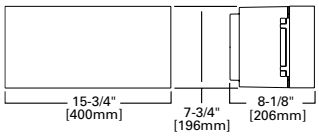
ENC/ENT/ENV
ENTRI LED

LightSquare
Solid State LED

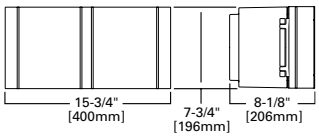
ARCHITECTURAL WALL LUMINAIRE

DIMENSIONS

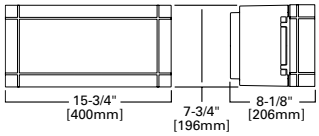
ENC (Round Clean)



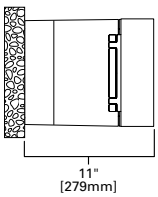
ENT (Triangle Reveals)



ENV (Round Reveals)



CONDUIT MOUNT / BATTERY BACK BOX



CERTIFICATION DATA

DesignLights Consortium® Qualified*
UL/cUL Listed
ISO 9001
IP66 LightSquares
LM79 / LM80 Compliant

ENERGY DATA

Electronic LED Driver
>0.9 Power Factor
<20% Total Harmonic Distortion
120-277V/50 & 60Hz, 347V/60Hz, 480V/60Hz
-30°C Minimum Temperature
40°C Ambient Temperature Rating (Optional)

SHIPPING DATA

Approximate Net Weight:
15.2 lbs. (6.9 kgs.) - Without backbox
29.1 lbs. (13.2 kgs.) - With backbox

TD516150EN
April 12, 2021 7:26 AM

COOPER Lighting Solutions

L11

ORDERING INFORMATION

Sample Number: ENC-SA1C-740-U-T4W-GM-ULG-HA-ZW-SWPD4BK

Product Family [1]	Light Engine		Color Temperature	Voltage	Distribution	Finish
	Configuration	Drive Current				
ENC=Entri Round Clean **ENT**=Entri Triangle Reveals **ENV**=Entri Round Reveals	**SA1**=1 Square	**A**=350mA **B**=450mA **C**=600mA **D**=800mA **E**=1000mA **F**=1200mA	**722**=70CRI, 2200K [3] **727**=70CRI, 2700K [3] **730**=70CRI, 3000K [3] **735**=70CRI, 3500K **740**=70CRI, 4000K **750**=70CRI, 5000K [3] **760**=70CRI, 5700K [3] **827**=80CRI, 2700K [3] **830**=80CRI, 3000K [3]	**U**=UNV (120-277) **1**=120 **2**=208 **3**=240 **4**=277 **8**=480 **9**=347	**T2**=Type II **T3**=Type III **T4FT**=Type IV Forward Throw **T4W**=Type IV Wide **SL2**=Type II w/Spill Control **SL3**=Type III w/Spill Control **SL4**=Type IV w/Spill Control **SLL**=90° Spill Light Eliminator Left **SLR**=90° Spill Light Eliminator Right	**BZ**=Bronze **AP**=Grey **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic **WH**=White

277V

Options (Add as Suffix)

F=Singled fused (Must specify voltage, fused on single hot leg of 120, 277, or 347)
FF=Doubled fused (Must specify voltage, fused on both hot legs of 208, 240, or 480)
X=Driver Surge Protection (6kV) Only
DIM=0-10V Dimming Driver [5, 6]
~~**EBP**=Battery Pack with Back Box (Must specify voltage, available in 120V or 277V) [2, 4, 9]~~
CBP=Battery Pack with Back Box, Cold Weather Rated (Must specify voltage, available in 120V or 277V) [2, 4, 10]
CBP-CEC=Battery Pack with Back Box, Cold Weather Rated, CEC compliant (Must specify voltage, available in 120V or 277V) [2, 4, 10]
R90=Rotated Right 90˚
L90=Rotated Left 90˚
HSS=Factory Installed House Side Shield [16]
LCF=LightSquare Trim Plate Matches Housing Finish [15]
ULG=Uplight Glow [7]
HA=50°C High Ambient [8]
WG=Wire Guard
TR=Tamper Resistant Hardware
BOX=Empty back box (1/2" NPT, each side with plugs installed
BPC=Button Type Photocontrol (Must specify voltage, available in 120, 208, 240, 277V, 347, and 480)
AHD145=After Hours Dim, 5 Hours, 50% [17]
AHD245=After Hours Dim, 6 Hours, 50% [17]
AHD255=After Hours Dim, 7 Hours, 50% [17]
AHD355=After Hours Dim, 8 Hours, 50% [17]
SPB1=Dimming Occupancy Sensor with Bluetooth Interface, <8' Mounting [13, 22]
SPB2=Dimming Occupancy Sensor with Bluetooth Interface, 8'-20' Mounting [13, 22]
SPB4=Dimming Occupancy Sensor with Bluetooth Interface, 21'-40' Mounting [13, 22]
MS-L08=Motion Sensor for ON/OFF Operation, Up to 8' Mounting Height [11, 12, 13]
MS-L20=Motion Sensor for ON/OFF Operation, 9' - 20' Mounting Height [11, 12, 13]
MS/DIM-L08=Motion Sensor for Dimming Operation, Up to 8' Mounting Height [11, 12, 13]
MS/DIM-L20=Motion Sensor for Dimming Operation, 9' - 20' Mounting Height [11, 12, 13]
ZW=Wavelinx-enabled 4-PIN Twistlock Receptacle [19, 20]
ZW-SWPD4XX=Wavelinx Wireless Sensor, 7' - 15' Mounting Height [19, 20, 21]
ZW-SWPD5XX=Wavelinx Wireless Sensor, 15' - 40' Mounting Height [19, 20, 21]
20K=Series 20kV UL 1449 Surge Protective Device
CC=Coastal Construction [23]

Provide for EM lights only

Accessories (Order Separately)

MA1253=10kV Circuit Module Replacement
MA1253-480V=10kV Circuit Module Replacement (480V only)
FSIR-100-PK=Wireless Configuration Tool for Occupancy Sensor [11]
VA6172SA=Wireguard Accessory
VA6173=Tamper-Resistant Driver Bit
VA6174=Vandal Shield Accessory
VA2001-XX=Thru-Way Conduit Box
SWPD4-XX=Wavelinx Wireless Sensor, 7' – 15' Mounting Height (Available colors: BZ=Bronze; WH=White; BK=Black) [19, 20, 21]
SWPD5-XX=Wavelinx Wireless Sensor, 15' – 40' Mounting Height (Available colors: BZ=Bronze; WH=White; BK=Black) [19, 20, 21]
WOLC-7P-10A=WaveLinx Outdoor Control Module (7-pin)
LS/HSS=House Side Shield (Works with all distributions listed for Entri)

NOTES:
1. DesignLights Consortium® Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details. DLC Family Code: MMMSPQ
2. EBP or CBP options limited to 25°C, 120-277V only. Control option limited to BPC=Button Type Photocontrol (must specify voltage).
3. Extended lead times apply. Use dedicated IES files when performing layouts.
4. Not available with HA option.
5. Cannot be used with other control options.
6. Low voltage control lead brought out 18" outside fixture.
7. ULG only available in 740
8. Not available with ULG option
9. EBP is rated for minimum operating temperature of 0°C (32°F). Operates downlight for 90-minutes.
10. CBP is rated for minimum operating temperature of -20°C (-4°F). Operates downlight for 90-minutes.
11. The FSIR-100 configuration tool is required to adjust parameters including high and low modes, sensitivity, time delay, cutoff and more. Consult your lighting representative at Cooper Lighting
12. Replace LXX with the available mounting height options: L08, L20, L40 or L40W are the only choices.
13. Includes integral photosensor.
14. Bronze sensor is shipped with Bronze fixtures. White sensor shipped on all other housing color options.
15. Not available with HSS option.
16. Only for use with SL2, SL3 and SL4 distributions. The light square trim plate is painted black when the HSS option is selected.
17. Requires the use of BPC photocontrol. See After Hours Dim supplemental guide for additional information.
18. Control option limited to BPC=Button Type Photocontrol (must specify voltage).
19. WAC Gateway required to enable field-configurability: Order WAC-PoE and WPOE-120 (10V to PoE injector) power supply if needed.
20. Requires ZW.
21. Replace XX with sensor color (WH, BZ, or BK).
22. Smart device with mobile application required to change system defaults. See controls section for details.
23. Coastal construction finish salt spray tested to over 5,000-hours per ASTM B117, with a scribe rating of 9 per ASTM D1654.

POWER AND LUMENS

L11

1 LightSquare (SA Series)			**ENC (Entri - Round Clean) / ENT (Entri - Triangle Reveals) / ENV (Entri - Round Reveals)**						
Drive Current (mA)			EBP / CBP	SA1A (350mA)	SA1B (450mA)	SA1C (600mA)	SA1D (800mA)	SA1E (1000mA)	SA1F (1200mA)
Power (Watts)		120-277V±	13	20.1	25.4	33.3	43.1	57.2	66.1
Current (A)		120V	--	0.17	0.22	0.29	0.38	0.48	0.56
		277V	--	0.09	0.1	0.13	0.17	0.21	0.25
Power (Watts)		347V or 480V	--	23.3	28.7	36.6	49.5	60.7	70.1
Current (A)		347V	--	0.07	0.08	0.11	0.15	0.18	0.21
		480V	--	0.05	0.06	0.08	0.11	0.13	0.16
Optics									
740 CCT	**T4W (Type IV Wide)**	Lumens	772	2,733	3,428	4,511	5,646	7,034	7,785
		Lumens per Watt‡	59.4	136.0	135.0	135.5	131.0	123.0	117.8
		BUG Rating	B0-U0-G0	B1-U0-G1	B1-U0-G1	B1-U0-G1	B1-U0-G2	B1-U0-G2	B2-U0-G2
	T4W-HSS (Type IV Wide, House Side Shield)	Lumens	576	2,039	2,556	3,364	4,210	5,246	5,806
		Lumens per Watt‡	44.3	101.4	100.6	101.0	97.7	91.7	87.8
		BUG Rating	B0-U0-G0	B0-U0-G1	B0-U0-G1	B0-U0-G1	B1-U0-G1	B1-U0-G2	B1-U0-G2
	T4W-ULG (Type III, House Side Shield)	Lumens	772	4,511	5,206	6,289	7,424	8,812	9,563
		Lumens per Watt‡	59.4	122.6	123.7	125.8	124.1	119.2	115.5
		BUG Rating	--	--	--	--	--	--	--
	T4W-HSS-ULG (Type III, House Side Shield)	Lumens	576	3,817	4,334	5,142	5,988	7,024	7,584
		Lumens per Watt‡	44.3	103.7	102.9	102.8	100.1	95.0	91.6
		BUG Rating	--	--	--	--	--	--	--
	SL2 (Type II w/Spill Control)	Lumens	762	2,700	3,386	4,456	5,577	6,948	7,690
		Lumens per Watt‡	58.6	134.3	133.3	133.8	129.4	121.5	116.3
		BUG Rating	B0-U0-G0	B1-U0-G1	B1-U0-G1	B1-U0-G1	B1-U0-G2	B2-U0-G2	B2-U0-G2
	"SL2-HSS (Type II w/Spill Control, House Side Shield)	Lumens	624	2,210	2,771	3,646	4,564	5,686	6,293
		Lumens per Watt‡	48.0	110.0	109.1	109.5	105.9	99.4	95.2
		BUG Rating	B0-U0-G0	B0-U0-G1	B1-U0-G1	B1-U0-G1	B1-U0-G1	B1-U0-G2	B1-U0-G2
	"SL2-ULG (Type III, House Side Shield)"	Lumens	762	4,478	5,164	6,234	7,355	8,726	9,468
		Lumens per Watt‡	58.6	121.7	122.7	124.7	123.0	118.1	114.3
		BUG Rating	--	--	--	--	--	--	--
	"SL2-HSS-ULG (Type III, House Side Shield)"	Lumens	624	3,988	4,549	5,424	6,342	7,464	8,071
		Lumens per Watt‡	48.0	108.4	108.1	108.5	106.1	101.0	97.5
		BUG Rating	--	--	--	--	--	--	--
	"SL3 (Type III w/Spill Control)"	Lumens	757	2,682	3,363	4,425	5,539	6,901	7,638
		Lumens per Watt‡	58.2	133.4	132.4	132.9	128.5	120.6	115.6
		BUG Rating	B0-U0-G0	B1-U0-G1	B1-U0-G1	B1-U0-G1	B1-U0-G2	B1-U0-G2	B1-U0-G2
	"SL3-HSS (Type III w/Spill Control, House Side Shield)"	Lumens	647	2,290	2,872	3,780	4,731	5,894	6,524
		Lumens per Watt‡	49.8	113.9	113.1	113.5	109.8	103.0	98.7
		BUG Rating	B0-U0-G0	B0-U0-G1	B1-U0-G1	B1-U0-G1	B1-U0-G1	B1-U0-G2	B1-U0-G2
	"SL3-ULG (Type III, House Side Shield)"	Lumens	757	4,460	5,141	6,203	7,317	8,679	9,416
		Lumens per Watt‡	58.2	121.2	122.1	124.1	122.4	117.4	113.7
		BUG Rating	--	--	--	--	--	--	--
	"SL3-HSS-ULG (Type III, House Side Shield)"	Lumens	647	4,068	4,650	5,558	6,509	7,672	8,302
		Lumens per Watt‡	49.8	110.5	110.5	111.2	108.8	103.8	100.3
		BUG Rating	--	--	--	--	--	--	--
	"SL4 (Type IV w/Spill Control)"	Lumens	732	2,592	3,250	4,277	5,353	6,670	7,383
		Lumens per Watt‡	56.3	129.0	128.0	128.4	124.2	116.6	111.7
		BUG Rating	B0-U0-G0	B1-U0-G1	B1-U0-G1	B1-U0-G1	B1-U0-G2	B1-U0-G2	B1-U0-G2
	"SL4-HSS (Type IV w/Spill Control, House Side Shield)"	Lumens	633	2,243	2,813	3,701	4,633	5,772	6,389
		Lumens per Watt‡	48.7	111.6	110.7	111.1	107.5	100.9	96.7
		BUG Rating	B0-U0-G0	B0-U0-G1	B0-U0-G1	B0-U0-G1	B1-U0-G2	B1-U0-G2	B1-U0-G2

L11

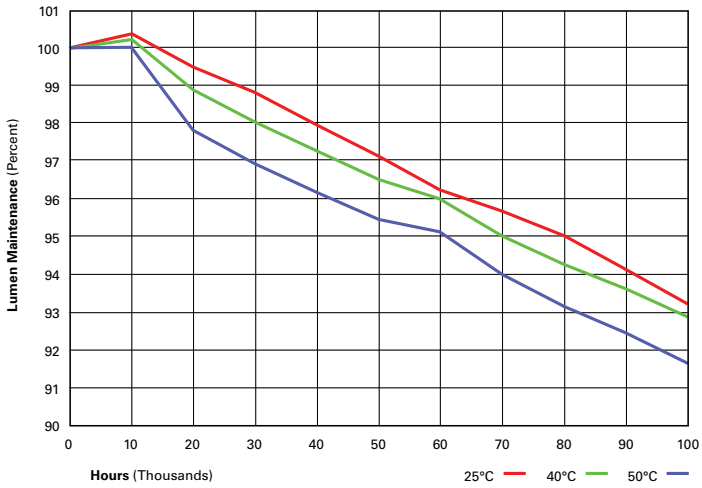
LUMEN MAINTENACE

SA1 (All Drive Currents)					
Hours	**25,000 hours***	**50,000 hours***	**60,000 hours***	**100,000 hours****	**Theoretical L70 (Hours)****
25˚C	99.4%	99.0%	98.9%	98.3%	2,471,000
40˚C	99.4%	99.0%	98.9%	98.3%	2,471,000
50˚C	99.4%	99.0%	98.9%	98.3%	2,471,000

* Supported by IES TM-21 standards
** Theoretical values represent estimations commonly used; however, refer to the IES position on LED Product Lifetime Prediction, IES PS-10-18, that explains proper use of IES TM-21 and LM-80.

LUMEN MULTIPLIER

Ambient Temperature	SA1 (All Drive Currents)
0˚C	1.02
10˚C	1.01
25˚C	1.00
40˚C	0.99
50˚C	0.97



CONTROL OPTIONS

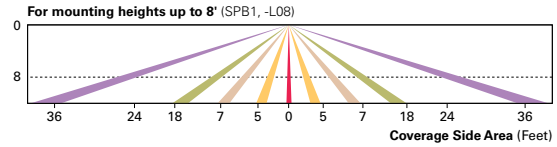
0-10V
This fixture is offered standard with 0-10V dimming driver(s). The DIM option provides 0-10V dimming wire leads for use with a lighting c
panel or other control method.

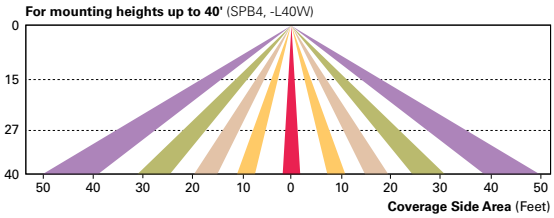
L11

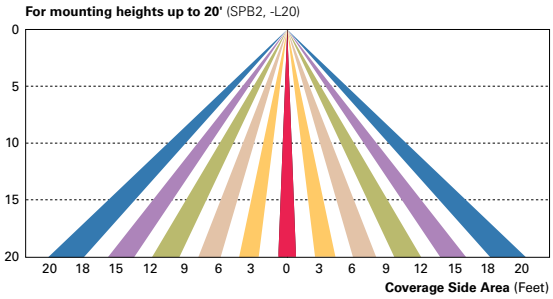
Photocontrol (BPC)
Optional button-type photocontrol (BPC) and photocontrol receptacles (PR and PR7) provide a flexible solution to enable “dusk-to-dawn” lighting by sensing light levels. Advanced control systems compatible with NEMA 7-pin standards can be utilized with the PR7 receptacle.

After Hours Dim (AHD)
This feature allows photocontrol-enabled luminaires to achieve additional energy savings by dimming during scheduled portions of the night. The dimming profile will automatically take effect after a “dusk-to-dawn” period has been calculated from the photocontrol input. Specify the desired dimming profile for a simple, factory-shipped dimming solution requiring no external control wiring. Reference the After Hours Dim supplemental guide for additional information.

Dimming Occupancy Sensor (MS/DIM-LXX and MS-LXX)
These sensors are factory installed in the luminaire housing. When the SPB or MS/DIM sensor options are selected, the occupancy sensor is connected to a dimming driver and the entire luminaire dims when there is no activity detected. When activity is detected, the luminaire returns to full light output. The MS/DIM sensor is factory preset to dim down to approximately 50 percent power with a time delay of five minutes. The MS-LXX sensor is factory preset to turn the luminaire off after five minutes of no activity. SPB motion sensors require the Sensor Configuration mobile application by Wattstopper to change factory default dimming level, time delay, sensitivity and other parameters. Available for iOS and Android devices. The SPB sensor is factory preset to dim down to approximately 10% power with a time delay of five minutes. The MS/DIM occupancy sensors require the FSIR-100 programming tool to adjust factory defaults.







WaveLinx Wireless Control and Monitoring System
Available in 7-PIN or 4-PIN configurations, the WaveLinx Outdoor control platform operates on a wireless mesh network based on IEEE 802.15.4 standards enabling wireless control of outdoor lighting. Use the WaveLinx Mobile application for set-up and configuration. At least one Wireless Area Controller (WAC) is required for full functionality and remote communication (including adjustment of any factory pre-sets). WaveLinx Outdoor Control Module (WOLC-7P-10A) A photocontrol that enables astronomic or time-based schedules to provide ON, OFF and dimming control of fixtures utilizing a 7-PIN receptacle. The out-of-box functionality is ON at dusk and OFF at dawn. WaveLinx Wireless Sensor (SWPD4 and SWPD5) These outdoor sensors offer passive infrared (PIR) occupancy and a photocell for closed loop daylight sensing. These sensors can be factory installed or field-installed via simple, tool-less integration into luminaires equipped with the Zhaga Book 18 compliant 4-PIN receptacle (ZW). These sensors are factory preset to dim down to approximately 50 percent power after 15 minutes of no activity detected. These occupancy sensors include an integral photocell for "dusk-to-dawn" control or daylight harvesting that is factory-enabled. A variety of sensor lenses are available to optimize the coverage pattern for mounting heights from 7'-20', only applies for typical wall packs.

Lyon - Suspended

SIP12104 49 in

JOB NAME:
TYPE:
NOTES:

SPI LIGHTING
PROJECT DETAILS
L12

DESCRIPTION

Lyon is a family of small-scale linear LED fixtures that delivers impressive performance at an affordable price. Designed for continuous runs, it features end-to-end connections with minimal seams. Lyon's low-profile housing and discreet canopy provide a clean, streamlined appearance. The lens, available in five shapes, softly diffuses light with minimal glare. Lyon's simple design and versatility make it suitable for many kinds of spaces. Available in interior and exterior pendant, ceiling, and wall mount versions in 4' and 8' lengths.

designed for LED | EMR

FEATURES & BENEFITS

- Choose from 5 diffuser shapes
- Configure in a run or hang as a pendant
- Housing is engineered to act as an efficient heat sink, maximizing output and life by allowing the LEDs to operate at optimal temperatures
- Up to 1495 lm/foot delivered at high wattage
- Semi-direct distribution of 89% direct/11% indirect
- Anodized finish provides durable corrosion protection
- Available in low, medium and high wattages
- Provides functional lighting with comfortable luminance levels
- Handcrafted in USA

SPECIFICATIONS

- **LIGHT SOURCE:** White LED light engine
- **CRI:** 80+ (contact factory for 90+)
- **LUMEN MAINTENANCE:** L70 = >50,000 Hrs.
- **EFFICACY:** 105 lm/W delivered
- **CCT**: 3000K, 3500K, or 4000K
- **VOLTAGE:** 120-277V standard
- **DRIVER:** Includes remote Class 2 power supply, enclosure and white power cord(s). Continuous runs are supplied with one power supply per fixture. Max distance to the driver (including OAH) is: #18 AWG = 50', #16 AWG = 75', #14 AWG = 100'. For extended distances, contact factory.
- **DIMMING:** 0-10V controls standard to 1%

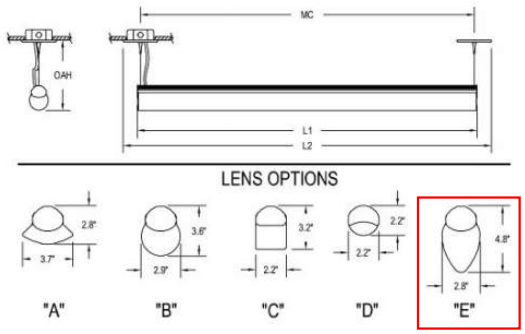
18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 119
H+B

- **EMERGENCY:** Emergency battery remote optional
- **INTEGRATED SURGE PROTECTION:** LED components are protected against minor surge events
- **LENS:** Diffused acrylic lens
- **CONSTRUCTION:** Housing fabricated from 6000 series aluminum extrusion
- **FINISH:** Housing available in anodized finish only with end cap and mounting components painted to match
- **MODIFICATIONS:** Consult factory for all modification requests, including RGB and static LED colors
- **APPROVALS:** ETL listed to UL standards (US & Canada) for use in damp locations; not recommended for exterior applications

L12

DIMENSIONS



L1	L2	OAH	MC
49.1 in 124.7 cm	53.2 in 135.1 cm	36 in 91.4 cm	47.3 in 120.1 cm

Mounting Weight
Consult Factory.

CONFIGURATOR

To configure your spec sheet online, go to www.spilighting.com/SIP12104. Not all options are available in all configurations; consult factory for details.

Required Field *

Catalog	Light Source*	Primary Finish*	Voltage*	Lamp Options*	Mounting*	Linear Run	Emergency	Lens Shapes*	Options	Other Than Standard Options
SIP12104										
									Finish:	
	A		B	C	D	E	F	G	H	I

A - LIGHT SOURCE *

To ensure color consistency, SPI uses precise bin selection and strict quality processes to maintain a 3-step (MacAdam) SDCM on all white LED lampings. Published LED luminaire wattages are calculated using a typical power supply efficiency of 88%; exact wattages may vary based on application. Alternative wattages available upon request.

☐ **L14W** | White 14W LED Light Engine| Delivered Lumens: 1,470
☐ **L28W** | White 28W LED Light Engine| Delivered Lumens: 2,940

☐ **L56W** | White 56W LED Light Engine| Delivered Lumens: 5,880

See last page for finish options

L12

B - VOLTAGE *

☐ **120-277V** | Universal Voltage

C - LAMP OPTIONS *

Delivered lumens shown are at 4000K CCT; apply multiplier for delivered lumens at other CCT.

☐ **3000K** [1] | 3000K CCT
☐ **3500K** [2] | 3500K CCT
☐ **4000K** | 4000K CCT

[1] Apply .95 multiplier for delivered lumens

[2] Apply .97 multiplier for delivered lumens

D - MOUNTING *

Mounts to standard 4" octagonal junction box. Default CAA mounting features two canopies and two aircraft cables that are field adjustable to allow the fixture to be mounted at an application appropriate height. Canopies and power cord are white. INSTALLATION NOTES: During installation the contractor is responsible to use actual fixtures to ensure accurate mounting centers from one fixture to the next along the length of the linear run.

☐ **DF_CAA** | 5"Canopies, Aircraft Cable, Power Cord & Remote Supply (default)
☐ **CAS** [3] | 5" Canopies & 5/8" Stems, Remote Supply

[3] Stems and canopies are painted to match anodized finish

E - LINEAR RUN

Select this option only for runs longer than 4'. Continuous runs are configured with standard 4' and 8' sections; consult factory for other lengths.

☐ **RUN** [4] | Continuous Run **OAL** | Specify Length of Run Length: 4'-0"

[4] For a take-off and pricing, contact factory

F - EMERGENCY

☐ **EMR** | Emergency Battery Remote

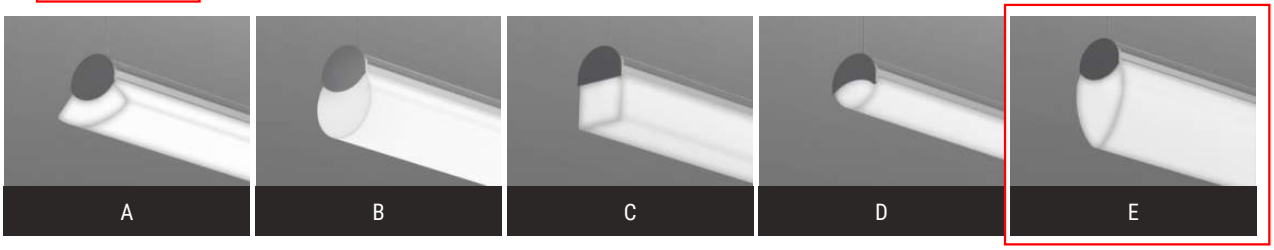
Provide for EM lights only

G - LENS SHAPES *

L12

Shown at top with shape "B". See line art for dimensions.

- ☐ **A** | Lens Shape "A"
- ☐ **B** | Lens Shape "B"
- ☐ **C** | Lens Shape "C"
- ☐ **D** | Lens Shape "D"
- ☐ **E** | Lens Shape "E"



H - OPTIONS

Alternate end cap finish (AEF) specified separately.

- ☐ **AEF** [5] | Alternate End Cap Finish (See last page for finish options)

[5] Available in painted finishes only

I - OTHER THAN STANDARD OPTIONS

Specify overall height required from ceiling to the bottom of the fixture.

OAH | Pendant suspension length other than standard Length:

Available Finishes

Not all finishes are available in all configurations; consult factory for details.

L12

Anodized

AN04 Anodized	

Paint Colors

PT01 Super White (Gloss)	**PT02** White (Textured)	**PT03** Morning Light (Textured)	**PT04** Warm White (Textured)	**PT05** Putty (Textured)
PT06 Warm Beige (Textured)	**PT07** Light Taupe (Textured)	**PT08** Medium Taupe (Textured)	**PT09** Medium Grey (Textured)	**PT10** Dark Grey (Textured)
PT11 Black (Textured)	**PT12** Dark Chocolate (Textured)	**PT13** Warm Grey (Textured)	**PT14** Light Grey (Textured)	**PT15** Sage (Textured)
PT16 Spruce (Textured)	**PT17** Red (Textured)	**PT18** Deep Red (Textured)	**PT19** Blue (Textured)	**PT20** Dark Green (Textured)
PT21 Pearl White (Metallic Gloss)	**PT22** Platinum (Metallic Gloss)	**PT27** Deep Copper (Metallic Gloss)	**PT28** Dark Stainless (Metallic Gloss)	**PT29** Red Brass (Metallic Gloss)
PT31 Medium Bronze (Metallic Gloss)	**PT32** Dark Bronze (Metallic Gloss)	**PT33** Dark Blue (Textured)	**PT40** Yellow (Textured)	**PT41** Orange (Textured)
PT42 Sky Blue (Textured)	**PT43** Teal (Textured)	**PT44** Green (Textured)	**PT45** Purple (Textured)	**PT46** Aluminum (Metallic Textured)
PT47 Deep Red Brass (Metallic Textured)	**PT48** Brass (Metallic Textured)	**PT49** Bronze (Metallic Textured)	**PT51** Matte White (Textured)	

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L13

DIGITAL NAVIGATION

Ordering Tree nLight Platform Sensor Switch JOT Photometrics Performance Data

Low Profile LED Wraparound

BLWP

2', 4' and 8' Lengths

FEATURES & SPECIFICATIONS

INTENDED USE — The BLWP LED Wrap/ Wall bracket expands the BLT family with the features and aesthetics of the popular BLT and BLTR center basket design with a clean, versatile style and volumetric distribution. High efficacy LED light engines deliver energy savings and low maintenance compared to traditional sources. An extensive selection of configurations and options make the BLWP the perfect choice for many lighting applications including schools, offices, stairwells and other commercial spaces. With multiple mounting options, easy installation, and controls configurations, the BLWP is an excellent choice for renovation and new construction.

CONSTRUCTION — BLWP enclosure components are die-formed for dimensional consistency. For 2' and 4' product, hinged door frame allows easy access to electrical components and mounting locations without having to remove additional parts. For 8' product, suspension aircraft cables allow easy access to electrical components and mounting locations without having to remove additional parts. Available in three paint finishes: white (pre-paint), painted after fabrication white, and natural aluminum. Diffusers are extruded from impact modified acrylic for increased durability. Optional polycarbonate lens available for additional impact resistance, as well as Tamper Proof screws.

OPTICS — Volumetric illumination is achieved by creating an optimal mix of light to walls, partitions and vertical and horizontal work surfaces – rendering the interior space, objects and occupants in a more balanced, complimentary luminous environment. High performance extruded acrylic diffusers conceal LEDs and efficiently deliver light in a volumetric distribution. Five diffuser choices available - curved and square designs with ribbed, a smooth frosted finish, and a smooth polycarbonate finish.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and qualityof illumination for extended service life. 80% LED lumen maintenance at 60,000 hours (L80/60,000). Replaces 2 lamp fluorescent.

Configurable BLWP: Available in High Efficiency (HE) versions for applications where a lower wattage (over the standard product) is required. The High Efficiency versions deliver >130 LPW and can be specified via the Lumen Package designations in the Ordering Information on page 2.

eldoLED driver options deliver choice of dimming range, and choices for control, while assuring flicker-free, low-current inrush, 89% efficiency and low EMI.

Optional integrated nLight®controls make each luminaire addressable - allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Connection to nLight is simple. It can be accomplished with integrated nLight AIR wireless or through standard Cat-5 cabling. nLight offers unique plug-and-play convenience as devices and luminaires automatically discover each other and self-commission, while nLight AIR is commissioned easily through an intuitive mobile app.

Lumen Management: Unique lumen management system (option N80) provides on board intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life, preventing the energy waste created by the traditional practice of over-lighting.

Driver disconnect provided where required to comply with US and Canadian codes.

CONTROLS — **Integrated sensor (individual control):** Sensor Switch MSD7ADCX (Passive infrared (PIR)) or MSDPDT7ADCX (PIR/Microphonics Dual Tech (PDT)) integrated occupancy sensor/automatic dimming photocell allows the luminaire to power off when the space is unoccupied or enough ambient light is entering the space.

Integrated Sensor (nLight Wired Networking): This sensor is nLight-enabled, meaning it has the ability to communicate over an nLight network. When wired, using CAT-5 cabling, with other nLight-enabled sensors, power packs, or WallPods, an nLight control zone is created. Once linked to a Gateway, directly or via a Bridge, the zone becomes capable of remote status monitoring and control via SensorView software. See page 5 for the nLight sensor options.

Integrated Smart Sensor (nLight AIR Wireless Platform): The rES7 sensor is nLight AIR enabled, meaning it has the ability to communicate over the wireless nLight control platform. It is available with an automatic dimming photocell, and either a digital PIR or dual technology occupancy sensor. It pairs to other luminairs and wall switches through our mobile app, CL***AIR***ITY PRO, which allows for simple sensor adjustment. See page 5 for more details on the Integrated Smart Sensor.

Integrated Wireless Sensor (single room control): Sensor Switch VERTEX JOT or JOTVTX15 luminaire-embedded occupancy and ambient light sensor allows the luminaire to power off when the space is unoccupied or when enough ambient light is entering the space. See page X for more details on the integrated wireless sensor.

INSTALLATION — Intended for surface or suspend mounting. For row mounting and quick mounting to junction boxes see accessories section. Suitable for damp location.

LISTINGS — CSA Certified to meet U.S. and Canadian standards.

DesignLights Consortium® (DLC) Premium qualified product. Not all versions of this product may be DLC Premium qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

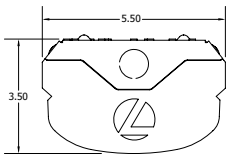
BUY AMERICAN — Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

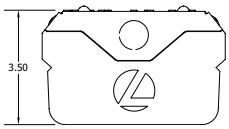
Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

Specifications

2' Dimensions
Length: 24 (60.96)
Width: 5.50 (13.97)
Depth: 3.50 (8.89)



4' Dimensions
Length: 48 (121.92)
Width: 5.50 (13.97)
Depth: 3.50 (8.89)



8' Dimensions
Length: 96 (243.84)
Width: 5.50 (13.97)
Depth: 3.50 (8.89)

All dimensions are inches (centimeters) unless otherwise specified.

FIXTURE REQUIRED TO BE DLC LISTED

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or control networks marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

BLWP Low Profile LED Wraparound

A+ Capable options indicated by this color background.

L13

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: BLWP4 40L ADP GZ10 LP840

Series		Lumens ‡				Lens/Diffuser		Driver		Driver		Color Temperature	
		Standard Efficiency (>100 LPW)		High Efficiency ‡ (>130 LPW)									
BLWP2	2' LED Wraparound	8L	800 Lumens	8LHE	800 Lumens	ADP	Curved, ribbed	(blank)	MVOLT	EZ1	eldoLED dims to 1% (0-10v dimming)	LP830	82CRI, 3000K
		20L	2000 Lumens	20LHE	2000 Lumens	ADSM	Curved, smooth	120	120V			LP835	82CRI, 3500K
		33L	3300 Lumens	33LHE	3300 Lumens	SDP	Square, ribbed	277	277V	GZ1	Generic dims to 1% (0-10v dimming) ‡	LP840	82CRI, 4000K
		40L	4000 Lumens	40LHE	4000 Lumens	SDSM	Square, smooth	347	347V ‡			LP850	82CRI, 5000K
		48L	4800 Lumens	48LHE	4800 Lumens	PDSM	Curved, smooth polycarbonate ‡			GZ10	Generic dims to 10% (0-10v dimming) ‡	LP930	90CRI, 3000K
BLWP4	4' LED Wraparound	15L	1500 Lumens	15LHE	1500 Lumens	**Diffusers w/ trim rings**						LP935	90CRI, 3500K
		20L	2000 Lumens	20LHE	2000 Lumens	ADPT	Curved, ribbed			SLD	Step-level dimming ‡	LP940	90CRI, 4000K
		30L	3000 Lumens	30LHE	3000 Lumens	ADSMT	Curved, smooth					LP950	90CRI, 5000K
		40L	4000 Lumens	40LHE	4000 Lumens	SDPT	Square, ribbed						
		48L	4800 Lumens	48LHE	4800 Lumens	SDSMT	Square, smooth						
		60L	6000 Lumens	60LHE	6000 Lumens	PDSMT	Curved, smooth polycarbonate ‡						
		72L	7200 Lumens	72LHE	7200 Lumens								
		85L	8500 Lumens	85LHE	8500 Lumens								
		100L	10000 Lumens	100LHE	10000 Lumens								
BLWP8	8' LED Wraparound	40L	4000 Lumens	40LHE	4000 Lumens								
		60L	6000 Lumens	60LHE	6000 Lumens								
		80L	8000 Lumens	80LHE	8000 Lumens								
		100L	10000 Lumens	100LHE	10000 Lumens								
		140L	14000 Lumens	140LHE	14000 Lumens								
		180L	18000 Lumens	180LHE	18000 Lumens								
		200L	20000 Lumens	200LHE	20000 Lumens								

nLight Interface ‡		Control ‡		
nLight Wired		**nLight Wired**		**Individual Control**
(blank)	no nLight® interface	(blank)	no nLight control	MSD7ADCX	PIR integral occupancy sensor with automatic dimming control photocell ‡
N80	nLight with 80% lumen management	NES7	nLight™ nES 7 PIR integral occupancy sensor ‡	MSDPDT7ADCX	PDT integral occupancy sensor with with automatic dimming control photocell ‡
N80EMG	nLight with 80% lumen management. For use with generator supply EM power ‡	NESPDT7	nLight™ nES PDT 7 dual technology integral occupancy control ‡	JOT	Wireless room control with "Just One Touch" pairing ‡
N100	nLight without lumen management	NES7ADCX	nLight™ nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell ‡	JOTVTX15	Wireless occupancy sensor with "Just One Touch" pairing ‡
N100EMG	nLight without lumen management. For use with generator supply EM power ‡	NESPDT7ADCX	nLight™ nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell ‡		
nLight Wireless		**nLight Wireless**			
(blank)	no nLight® interface	(blank)	no nLight control		
NLTAIR2	nLight AIR Generation 2 enabled ‡	RES7	nLight AIR PIR integral occupancy sensor with automatic dimming photocell for Networking Capabilities Individual Control ‡		
		RES7PDT	nLight AIR PIR integral occupancy sensor with automatic dimming photocell for Zone Control ‡		
		RIO	nLight AIR radio module without sensor ‡		
		RES7EM	nLight AIR PIR integral occupancy sensor with automatic dimming photocell and UL924 Emergency Operation, via power interrupt detection ‡		
		RES7PDTEM	nLight AIR microphonics dual technology occupancy sensor with automatic dimming photocell & UL924 Emergency Operation, via power interrupt detection ‡		
		RIOEM	nLight AIR radio module less sensor, with UL924 Emergency Operation, via power interrupt detection ‡		

Provide for EM lights only

Standby mode ‡		Options				Finish	
(blank)	Fixture with embedded sensor turns off when unoccupied	E10WLCP	EM Self-Diagnostic battery pack, 10W Constant Power, Certified in CA Title 20 MAEDBS	TRS	Tamper Resistant Screw ‡	(blank)	Standard pre-paint white
DIM10	Fixture with embedded sensor dims to approximately 10% light output when unoccupied ‡	EL7L	700 nominal lumens battery pack ‡	GLR	Fast-blowing fuse ‡	PAF	Paint After Fabrication White
DIM50	Fixture with embedded sensor dims to approximately 50% light output when unoccupied ‡	EL14L	1400 nominal lumens battery pack ‡	GMF	Slow-blowing fuse ‡	DNA	Paint After Fabrication Natural Aluminum
NOC	Occupancy sensor disabled ‡	BGTD	Bodine Generator Transfer Device ‡	FAO	Field Adjustable Output ‡		
		USPOM	US Point of Manufacture	PLR__	Plug-in wiring, see page 8 for ordering information ‡		
		QMB	Quick Mount Bracket ‡	PLR1LVG	Plug-in wiring,low voltage dimming ‡		
				BAA	Buy America(n) Act Compliant		

NOTE: ‡ indicates option value has ordering restrictions. Please reference the Option Value Ordering Restictions chart on the next page. Options are sorted alphanumerically.

See Stock configurations, Accessories and footnotes on page 4.

‡ Option Value Ordering Restrictions	
Option value	**Restriction**
347	Not available with E10WLCP, EL7L, EL14L, BGTD or BLWP4 > 85L/ 85LHE.
BLWPCR, BLWPCRDNA, BLWP8CR, BLWP8CRDNA	Cannot be used to continuous row mount 4' fixtures with 8' fixtures.
BGTD	Not available with JOT sensor options or emergency battery options. Must specify voltage. Requires BSE labeling, voltage specific. Consult factory for options. Example: BGTD BSE10.
DIM10, DIM50	Not available with NLTAIR2 or JOT sensor option. Requires occupancy control. Must be ordered with nLight Wired or Individual Control sensor option.
EL7L, EL14L	Only available on BLWP8, 8ft length version of this fixture, in lumen packages 140L or less.
FAO	EZ1 driver required. Not available with USPOM, FAO or lumen packages > 6000LM. FAO is not available with other integrated controls options and restricts the use of external dimming controls. See chart on page 5 for additional details.
GLR, GMF	Must specify voltage. 120 or 277, with GLR and GMF fusing.
GZ1, GZ10	Not available with any Control or Sensor options except JOT & JOTVTX15
JOT, JOTVTX15	Not available with SLD, NLIGHT, NLTAIR2, NOC, USPOM or FAO. Available only on 4' versions with ADPT and ADMST trim options; not available with > 72L or 72LHE lumen packages.
Lumens	Approximate lumen output. For high Efficiency, all versions may not achieve 130+ LPW including 90CRI and versions with integral sensor trim. Refer to photometry on www.acuitybrands.com. See QPL for latest DLC listings.
MSD7ADCX, MSDPDT7ADCX	Must select Lens/Diffuser type with Trim Rings. Not available with nLight interface. 0-10V wires are not accessible via access plate.
N80EMG, N100EMG	Requires a connection to existing nLight network. Power is provided from a separate NLIGHT enabled fixture or external power pack.
NES7, NESPDT7, NES7ADCX, NESPDT7ADCX	Must select Lens/Diffuser type with Trim Rings. Requires N80, N80EMG, N100, or N100EMG. Only available with EZ1 driver.
NLTAIR2	Must select nLight wireless control. Not available with JOT or JOTVTX15
NOC	Not available with JOT sensor options. Can only be ordered in conjunction with EZ1, NLTAIR2, RES7/RES7PDT. Occupancy sensor disabled at factory but can be re-enabled upon commissioning.
PDSM, PDSMT	Not available with HE (high efficiency) performance package on BLWP2 and BLWP4 only.
PLR___, PLR1LVG	Not available with BLWP2. PLR1LVG is not available with Controls options or nLight interface.
QMB	Not available with BLWP2 (2') or BLWP8 (8') fixture.
RES7, RES7PDT, RIO, RES7EM, RES7PDTEM, RIOEM	Must select Lens/Diffuser type with Trim Rings. Requires EZ1 and NLTAIR2 to be specified. Only available with 60L or lower lumen packages on the BLWP4. Only available with 100LHE/80L lumen packages or lower on the BLWP8.
SLD	Not available with any nLight Interface or Control options. Cannot be used with PLR1LVG
TRS	Accessory BLWP TRS T15 BIT available to be ordered with this option. See Accessories section page 3. Order as separate item.

Non-Configurable BLWP:

Stock/MTO	Ci code	Catalog Description	UPC	Lumens	Wattage	LPW	Color Temperature	Voltage	Pallet QTY
MTO	*264V2M	BLWP2 20L ADP LP835	191848282045	1942	17	117	3500 K	120-277	80
	*264V2L	BLWP2 20L ADP LP840	191848282038	1973	17	119	4000 K	120-277	80
	*264CH0	BLWP2 33L ADP LP835	191848080825	3332	30	112	3500 K	120-277	80
	*264CH1	BLWP2 33L ADP LP840	191848080832	3345	30	112	4000 K	120-277	80
	*264CH2	BLWP2 40L ADP LP835	191848080849	3923	37	105	3500 K	120-277	80
	*264CH4	BLWP2 40L ADP LP840	191848080856	4117	37	110	4000 K	120-277	80
STOCK	*264V2K	BLWP4 30L ADP LP835	191848282021	3065	25	123	3500 K	120-277	70
	*264V2H	BLWP4 30L ADP LP840	191848281994	3114	25	125	4000 K	120-277	70
	*264CH5	BLWP4 40L ADP LP835	191848080863	4391	35	127	3500 K	120-277	70
	*264CH6	BLWP4 40L ADP LP840	191848080870	4263	35	123	4000 K	120-277	70
	*264CH7	BLWP4 48L ADP LP835	191848080900	5137	40	129	3500 K	120-277	70
	*264CH8	BLWP4 48L ADP LP840	191848080917	5205	40	131	4000 K	120-277	70

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Accessories: *Order as separate catalog number.*

PART number	CI CODE	QTY	Description	Application
BLWP8/4CR	*272PFG	1	CONTINUOUS ROW MOUNT BRACKET FOR ROW CONNECTING BLWP4 and BLWP8 WHT	FOR USE TO MOUNT BLWP8 TO BLWP4, FOR STD FINISH AND PAF
BLWPCR	*250A0S	1	CONTINUOUS ROW MOUNT BRACKET WHT	FOR USE ON BLWP4 ONLY, FOR STD FINISH AND PAF ‡
BLWPCRDNA	*250A1S	1	CONTINUOUS ROW MOUNT BRACKET DNA	FOR USE ON BLWP4 ONLY, FOR DNA FINISH ‡
BLWP8CR	*2543C6	1	CONTINUOUS ROW MOUNT BRACKET WHT	FOR USE ON BLWP8 ONLY, FOR STD FINISH AND PAF ‡
BLWP8CRDNA	*2543CA	1	CONTINUOUS ROW MOUNT BRACKET DNA	FOR USE ON BLWP8 ONLY, FOR DNA FINISH ‡
BLWPCG36 F1	*264R3P	1	BLWPCG36 F1	ADJUSTABLE AIRCRAFT CABLE GRIPPER KIT, 36 INCH F1 CEILING TYPE
BLWPCG36 F2	*264R4G	1	BLWPCG36 F2	CABLE GRIPPER KIT, 36 INCH F2 CEILING TYPE
BLWPCG72 F1	*264R4H	1	BLWPCG72 F1	CABLE GRIPPER KIT, 72 INCH F1 CEILING TYPE
BLWPCG72 F2	*264R4M	1	BLWPCG72 F2	CABLE GRIPPER KIT, 72 INCH F2 CEILING TYPE
BLWPCGF36 F1	*264R4R	1	BLWPCGF36 F1	KIT WITH POWER FEED 36 INCH F1 CEILING TYPE
BLWPCGF36 F2	*264R4U	1	BLWPCGF36 F2	KIT WITH POWER FEED 36 INCH F2 CEILING TYPE
BLWPCGF72 F1	*264R4V	1	BLWPCGF72 F1	KIT WITH POWER FEED 72 INCH F1 CEILING TYPE
BLWPCGF72 F2	*264R4X	1	BLWPCGF72 F2	KIT WITH POWER FEED 72 INCH F2 CEILING TYPE
BLWPCGE36 F1	*264R50	1	BLWPCGE36 F1	KIT WITH EMERGENCY POWER FEED 36 INCH F1 CEILING TYPE
BLWPCGE36 F2	*264R5T	1	BLWPCGE36 F2	KIT WITH EMERGENCY POWER FEED 36 INCH F2 CEILING TYPE
BLWPCGE72 F1	*264R5V	1	BLWPCGE72 F1	KIT WITH EMERGENCY POWER FEED 72 INCH F1 CEILING TYPE
BLWPCGE72 F2	*264R53	1	BLWPCGE72 F2	KIT WITH EMERGENCY POWER FEED 72 INCH F2 CEILING TYPE
BLWPCGFD36 F1	*269V4M	1	BLWPCGFD36 F1	KIT WITH 0-10V DIMMING POWER FEED 36 INCH F1 CEILING TYPE
BLWPCGFD36 F2	*269V5C	1	BLWPCGFD36 F2	KIT WITH 0-10V DIMMING POWER FEED 36 INCH F2 CEILING TYPE
BLWPCGFD72 F1	*269V5N	1	BLWPCGFD72 F1	KIT WITH 0-10V DIMMING POWER FEED 72 INCH F1 CEILING TYPE
BLWPCGFD72 F2	*269V5X	1	BLWPCGFD72 F2	KIT WITH 0-10V DIMMING POWER FEED 72 INCH F2 CEILING TYPE
BLWP TRS T15 BIT	*2516KU	1	BLWP TRS T15 BIT	T15 WITH PIN, TORX BIT FOR TRS OPTION
BLWPQMB	*250A2S	1	BLWP Quick Mount Bracket	QUICK MOUNT BRACKET FOR INSTALLATION TO JUNCTION BOXES WITHOUT HAVING TO REMOVE ANY PARTS IN THE FIXTURE, 4FT FIXTURE ONLY.

nLight® Wired Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlight.

WallPod stations	Model number	Occupancy sensors	Model number
On/Off	nPODM [color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 RJB / nCM PDT 9 RJB
On/Off & raise/lower	nPODM DX [color]	Large motion 360°, ceiling (PIR / dual tech)	nCM10 RJB / nCM PDT 10 RJB
Graphic touchscreen	nPOD GFX [color]	Wall switch with raise/lower	nWSX PDT LV DX [color]
Photocell controls	**Model number**	**Cat-5 cable (plenum rated)**	**Model number**
Full range dimming	nCM ADCX RJB	10' cable	CAT5 10FT J1
		30' cable	CAT5 30FT J1

nLight® AIR Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlightair.

Wall switches	Model number
On/Off single pole	rPODB [color] G2
On/Off two pole	rPODB 2P [color] G2
On/Off & raise/lower single pole	rPODB DX [color] G2
On/Off & raise/lower two pole	rPODB 2P DX [color] G2
On/Off & raise/lower single pole	rPODBZ DX WH G2

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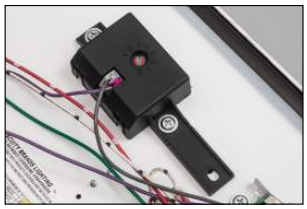
Replacement Parts: *Order as separate catalog number.*

2' Version Replacement Lens		4' Version Replacement Lens		8' Version Replacement Lens	
*264F5E	DBLWP24 ADP	*264F69	DBLWP48 ADP	*2543CE	DBLWP96 ADP
*264F5F	DBLWP24 SDP	*264F6E	DBLWP48 SDP	*2543CG	DBLWP96 SDP
*264F5H	DBLWP24 ADSM	*264F6F	DBLWP48 ADSM	*2543CJ	DBLWP96 ADSM
*264F5J	DBLWP24 SDSM	*264F6G	DBLWP48 SDSM	*2543CM	DBLWP96 SDSM
*264F5L	DBLWP24 ADPT	*264F6H	DBLWP48 ADPT	*2543CN	DBLWP96 ADPT
*264F5P	DBLWP24 SDPT	*264F6K	DBLWP48 SDPT	*2543CP	DBLWP96 SDPT
*264F5U	DBLWP24 ADSMT	*264F6L	DBLWP48 ADSMT	*2543CR	DBLWP96 ADSMT
*264F5W	DBLWP24 SDSMT	*264F6N	DBLWP48 SDSMT	*2543CS	DBLWP96 SDSMT
*264F66	DBLWP24 PDSM	*264F6W	DBLWP48 PDSM	*2543CW	DBLWP96 PDSM
*264F67	DBLWP24 PDSMT	*264F6X	DBLWP48 PDSMT	*2543CX	DBLWP96 PDSMT

FAO SETTINGS (Field Adjustable Output)

	0-10 Voltage Dimmer	% Lumen Output (approximate)	% Wattage (approximate)
Step 8	Full Output	100%	100%
Step 7	9.0 VDC	98%	100%
Step 6	8.0 VDC	88%	86%
Step 5	7.0 VDC	86%	82%
Step 4	6.0 VDC	82%	80%
Step 3	5.0 VDC	76%	75%
Step 2	4.0 VDC	71%	72%
Step 1	3.0 VDC	67%	71%

Simple adjustment of output through the use of a flat head screwdriver.

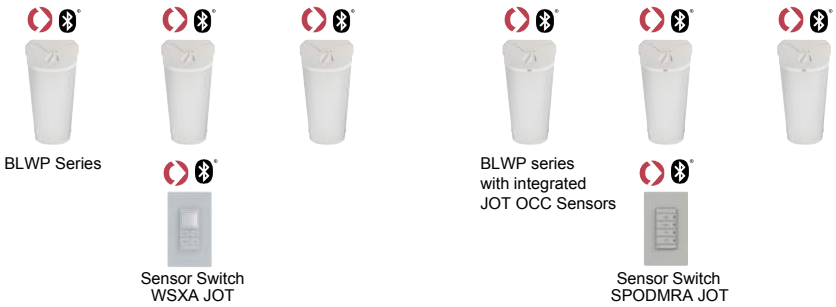


JOT Wireless

Sensor Switch JOT Enabled Wireless Solution

Designed with contractors in mind, the Sensor Switch JOT enabled wireless solution offers a straightforward approach to the installation and pairing of lighting fixtures and controls. Absolutely no 0-10V control wires and no mobile apps are needed with JOT enabled products, allowing for lightning speed installation right out of the box.

1. **Power:** Install JOT enabled fixtures and controls as instructed.
2. **Pair:** Insert the pairing tool into the pinhole on the wall switch; press and hold any button for 6 seconds.
3. **Play:** Once paired, each fixture will individually dim down to 10% brightness. All products will be fully functional.



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nLight Platform

nLight embedded fixtures offer:	Customers get:
Manual Dimming	Convenience and visual comfort for occupants
Motion Sensing and/or Daylight Harvesting	Energy savings and code compliance
Fixture or Group Level Control	Ability to configure lighting to the space requirements
Flexibility	Ease of fixture moves, adds and changes
Wireless Wall Switch (nLight AIR Only)	Ease and flexibility of placement
Astronomical and Time of Day Scheduling	Energy savings and building security
Scalable Solution	nLight controls to grow with your business
Future-Ready	nLight platform to set foundation for future upgrades and capabilities

nLight Air Wireless

Simple as 1,2,3

1. Install the nLight® AIR fixtures with embedded smart sensor
2. Install the wireless battery-powered wall switch
3. With CL**AIR**ITY app, pair the fixtures with the wall switch and if desired, customize the sensor settings for the desired outcome

nLight Wired Networking

Simple as 1,2,3

1. Install the nLight® Wired fixtures with embedded control
2. Install the nLight Wired wall switch
3. Connect the fixtures using standard CAT5e cables and the devices will automatically discover each other and work (plug and play)

MOUNTING INFORMATION

For unit or row installation; surface or suspend mounting.

Suspension Methods:

Aircraft Cable Suspension

Order one BLWPCG_, BLWPCGF_, or BLWPCGE_ required for each suspension point.

F1 for use with most T-bar and screw slot grid ceiling applications. Designed for on-grid and off-grid installations.

F2 for use with recessed or surface-mount horizontal J-box applications..

See Accessories page on page 3 for part numbers configurations.

Stem Suspension

Individual installation — Two single-stem hangers required.

Note: 2' configurations with emergency option cannot be stem mounted.

Accessory Images

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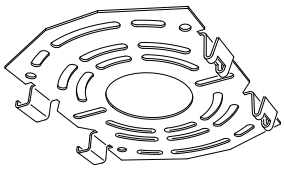
(QMB) Quick Mount Bracket

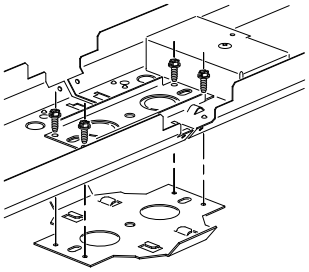
Quick Mount Bracket allows easy installation to junction boxes without having to remove any parts in the fixture.



Note: 2' and 8' configurations not available with QMB accessory.

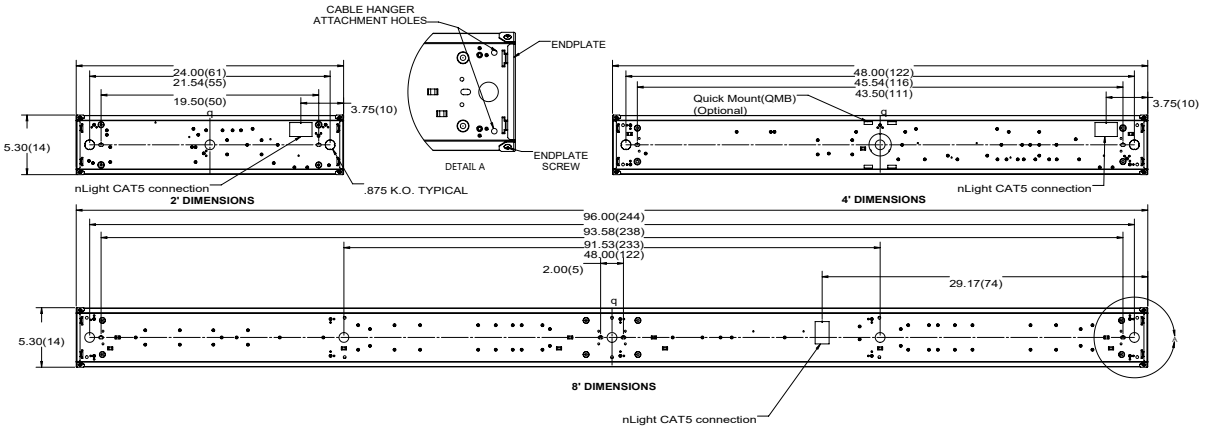
BLWPCR - continuous row mount bracket

Order one (1) BLWPCR bracket per fixture for continuous row applications. Order one hanger(Aircraft Cable Suspension Kit or Stem Suspension Kit) per fixture plus one per joiner required.



DIMENSIONS

All dimensions are inches (centimeters) unless otherwise noted.



PHOTOMETRICS

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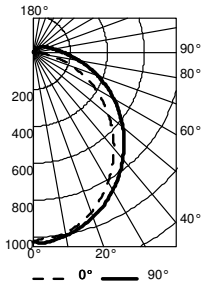
BLWP2 33L ADP LP835, 3332 delivered lumens, test no. ISF 37666, tested in accordance to IESNA LM-79.



CP Summary

	0°	90
0°	1024	1024
5°	1009	1027
15°	962	982
25°	867	910
35°	745	809
45°	604	694
55°	456	567
65°	303	436
75°	158	309
85°	36	202
90	0	161

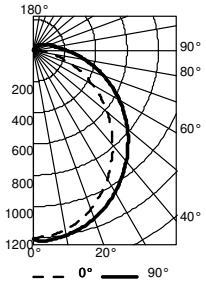
Coefficients of Utilization

	pf			20%					
	pc	80%			70%			50%	
RCR	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
	0	117	117	117	114	114	114	107	107	107
	1	106	100	96	97	93	89	92	88	85
	2	96	87	79	84	78	72	79	74	69
	3	87	76	67	74	66	59	70	63	57
	4	79	67	58	65	57	50	62	54	49
	5	73	60	51	58	50	43	55	48	42
	6	67	54	45	52	44	38	50	42	37
	7	62	49	40	48	39	33	45	38	32
	8	58	44	36	43	35	30	41	34	29
	9	54	41	32	40	32	27	38	31	26
	10	51	38	30	37	29	24	35	28	24

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	790	23.7	23.7
0° - 40°	1286	38.6	38.6
0° - 60°	2278	68.4	68.4
0° - 90°	3096	92.9	92.9
90° - 120°	184	5.5	5.5
90° - 130°	210	6.3	6.3
90° - 150°	233	7.0	7.0
90° - 180°	236	7.1	7.1
0° - 180°	3332	100.0	100.0

BLWP2 40L ADP LP835, 3923 delivered lumens, test no. ISF 37668, tested in accordance to IESNA LM-79.



CP Summary

	0°	90
0°	1210	1210
5°	1190	1219
15°	1130	1178
25°	1019	1100
35°	870	990
45°	706	856
55°	527	711
65°	352	560
75°	179	406
85°	37	268
90	1	214

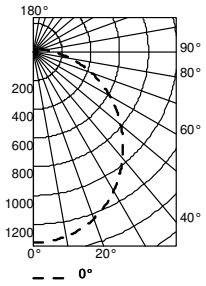
Coefficients of Utilization

	pf			20%					
	pc	80%			70%			50%	
RCR	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
	0	117	117	117	114	114	114	107	107	107
	1	106	100	96	97	93	89	92	88	85
	2	96	87	80	84	78	72	80	74	69
	3	87	76	67	74	66	60	70	63	58
	4	80	67	58	65	57	50	62	55	49
	5	73	60	51	58	50	43	55	48	42
	6	67	54	45	52	44	38	50	42	37
	7	62	49	40	48	39	33	45	38	32
	8	58	44	36	43	35	30	41	34	29
	9	54	41	32	40	32	27	38	31	26
	10	51	38	30	37	29	24	35	28	24

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	932	23.8	23.8
0° - 40°	1519	38.7	38.7
0° - 60°	2687	68.5	68.5
0° - 90°	3646	92.9	92.9
90° - 120°	215	5.5	5.5
90° - 130°	246	6.3	6.3
90° - 150°	273	7.0	7.0
90° - 180°	277	7.1	7.1
0° - 180°	3923	100.0	100.0

BLWP4 40L ADP LP835, 4391 delivered lumens, test no. ISF 37596, tested in accordance to IESNA LM-79.



CP Summary

	0°
0°	1324
5°	1321
15°	1274
25°	1180
35°	1043
45°	881
55°	705
65°	521
75°	343
85°	191
90	138

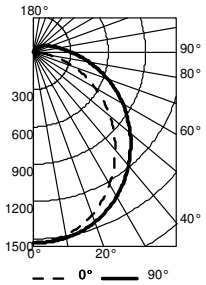
Coefficients of Utilization

	pf			20%					
	pc	80%			70%			50%	
RCR	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
	0	117	117	117	114	114	114	107	107	107
	1	106	100	95	97	93	89	92	88	85
	2	96	87	79	84	77	72	79	74	69
	3	87	76	67	74	66	59	70	63	57
	4	79	67	58	65	57	50	62	54	49
	5	73	60	50	58	49	43	55	48	42
	6	67	54	44	52	44	37	50	42	36
	7	62	48	40	47	39	33	45	38	32
	8	58	44	36	43	35	29	41	34	29
	9	54	41	32	40	32	26	38	31	26
	10	51	37	29	37	29	24	35	28	23

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1028	23.4	23.4
0° - 40°	1681	38.3	38.3
0° - 60°	2991	68.1	68.1
0° - 90°	4082	93.0	93.0
90° - 120°	249	5.7	5.7
90° - 130°	282	6.4	6.4
90° - 150°	307	7.0	7.0
90° - 180°	309	7.0	7.0
0° - 180°	4391	100.0	100.0

BLWP4 48L ADP LP835, 5137 delivered lumens, test no. ISF 37597, tested in accordance to IESNA LM-79.



CP Summary

	0°	90
0°	1528	1528
5°	1517	1528
15°	1447	1488
25°	1311	1398
35°	1129	1267
45°	913	1102
55°	691	920
65°	460	731
75°	233	540
85°	52	370
90	1	300

Coefficients of Utilization

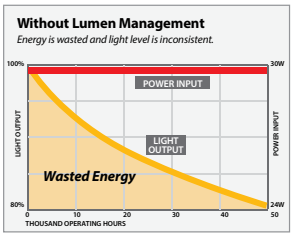
	pf			20%					
	pc	80%			70%			50%	
RCR	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
	0	117	117	117	114	114	114	107	107	107
	1	105	100	95	97	93	89	91	88	84
	2	95	86	79	84	77	71	79	73	69
	3	87	75	67	73	65	59	69	62	57
	4	79	67	57	65	56	50	61	54	48
	5	73	59	50	58	49	43	55	47	41
	6	67	53	44	52	43	37	49	42	36
	7	62	48	39	47	39	33	45	37	32
	8	58	44	35	43	35	29	41	34	28
	9	54	40	32	39	32	26	38	31	26
	10	51	37	29	36	29	24	35	28	23

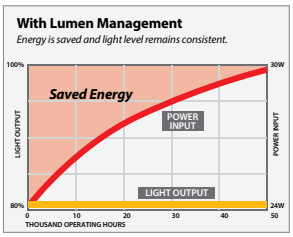
Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1188	23.1	23.1
0° - 40°	1944	37.8	37.8
0° - 60°	3464	67.4	67.4
0° - 90°	4754	92.5	92.5
90° - 120°	308	6.0	6.0
90° - 130°	349	6.8	6.8
90° - 150°	381	7.4	7.4
90° - 180°	383	7.5	7.5
0° - 180°	5137	100.0	100.0

Constant Lumen Management

Enabled by the embedded nLight control, the BLT actively tracks its run-time and manages its light source such that constant lumen output is maintained over the system life. Referred to as lumen management, this feature eliminates the energy waste created by the traditional practice of over-lighting.





How to Estimate Lumens in Emergency Mode
Use the formula below to estimate the delivered lumens in emergency mode
Estimated Lumens = 1.25 x P x LPW
P = Ouput power of emergency driver. P = 10W for E10WLCP option.
LPW = Lumen per watt rating of the luminaire. LPW information available in Performance Data section.

BLWP PERFORMANCE DATA [24]

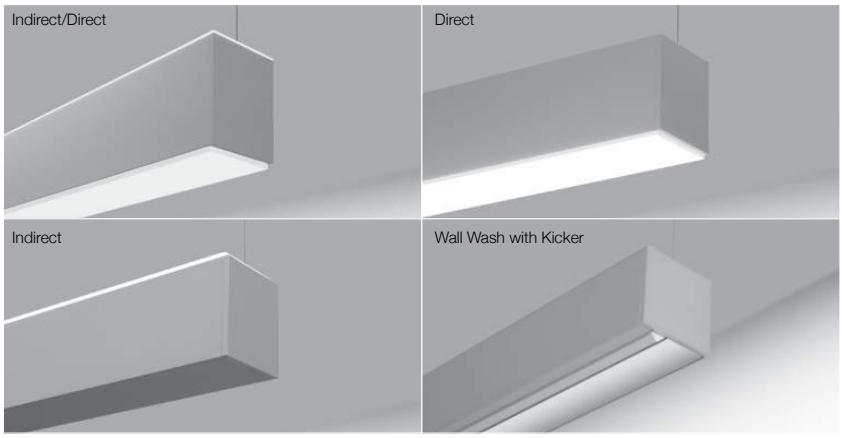
Lumen Package	Lumens	Input Watts	LPW
BLWP2 8L ADP LP830	825	7	118
BLWP2 8L ADP LP835	855	7	122
BLWP2 8L ADP LP840	868	7	124
BLWP2 8L ADP LP850	893	7	128
BLWP2 20L ADP LP830	1876	17	110
BLWP2 20L ADP LP835	1942	17	114
BLWP2 20L ADP LP840	1973	17	116
BLWP2 20L ADP LP850	2029	17	119
BLWP2 33L ADP LP830	3180	30	107
BLWP2 33L ADP LP835	3332	30	112
BLWP2 33L ADP LP840	3345	30	112
BLWP2 33L ADP LP850	3440	30	115
BLWP2 40L ADP LP830	3914	37	105
BLWP2 40L ADP LP835	3923	37	105
BLWP2 40L ADP LP840	4117	37	110
BLWP2 40L ADP LP850	4234	37	113
BLWP2 48L ADP LP830	4772	44	109
BLWP2 48L ADP LP835	4940	44	112
BLWP2 48L ADP LP840	5019	44	114
BLWP2 48L ADP LP850	5162	44	118
BLWP4 15L ADP LP830	1372	11	126
BLWP4 15L ADP LP835	1420	11	129
BLWP4 15L ADP LP840	1443	11	131
BLWP4 15L ADP LP850	1484	11	135
BLWP4 20L ADP LP830	1985	16	124
BLWP4 20L ADP LP835	2055	16	128
BLWP4 20L ADP LP840	2088	16	131
BLWP4 20L ADP LP850	2147	16	134
BLWP4 30L ADP LP830	2960	25	118
BLWP4 30L ADP LP835	3065	25	123
BLWP4 30L ADP LP840	3114	25	125
BLWP4 30L ADP LP850	3203	25	128
BLWP4 40L ADP LP830	4027	35	115
BLWP4 40L ADP LP835	4391	35	125
BLWP4 40L ADP LP840	4236	35	121
BLWP4 40L ADP LP850	4357	35	124
BLWP4 48L ADP LP830	4948	40	124
BLWP4 48L ADP LP835	5137	40	129
BLWP4 48L ADP LP840	5205	40	131
BLWP4 48L ADP LP850	5353	40	134
BLWP4 60L ADP LP830	6059	49	123
BLWP4 60L ADP LP835	6273	49	127
BLWP4 60L ADP LP840	6373	49	129
BLWP4 60L ADP LP850	6555	49	133
BLWP4 72L ADP LP830	7088	59	121
BLWP4 72L ADP LP835	7338	59	125
BLWP4 72L ADP LP840	7455	59	127
BLWP4 72L ADP LP850	7668	59	131
BLWP4 85L ADP LP830	7972	68	117
BLWP4 85L ADP LP835	8253	68	121
BLWP4 85L ADP LP840	8385	68	123
BLWP4 85L ADP LP850	8624	68	127
BLWP4 100L ADP LP830	9316	85	110
BLWP4 100L ADP LP835	9645	85	114
BLWP4 100L ADP LP840	9799	85	116
BLWP4 100L ADP LP850	10079	85	119

L13

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Pendant L14A



Signal White is standard finish

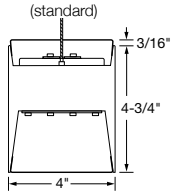
Note: see page 6 for all aesthetic options

High Performance 4" Aperture is a patented, linear LED luminaire family. HP-4 delivers excellent performance using an advanced optical design and mid-power LEDs. Achieving 90% of initial light output at 100,000+ hours and backed by a 10-year performance-based warranty on all standard components.

This product is enrolled in the International Living Future Institute (ILFI) Declare 2.0 Program and is third-party verified with options achieving **Red List Approved** and **Declared** status.

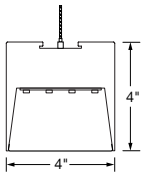
CROSS SECTIONS

Indirect/Direct
Top Glow Diffuser (standard)



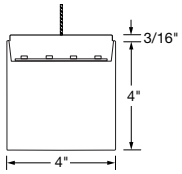
Flush Downlight Diffuser (standard)

Direct

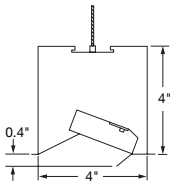


Flush Downlight Diffuser (standard)

Indirect
Top Glow Diffuser (standard)

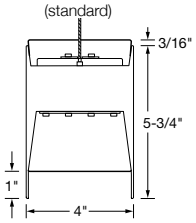


Wall Wash Direct



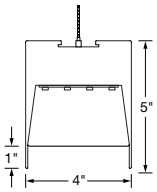
Kicker (standard)

Regressed Indirect/Direct
Top Glow Diffuser (standard)



Flat Diffuser with 1" Regressed (standard)

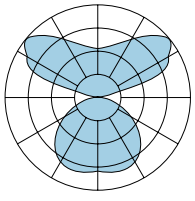
Regressed Direct



Flat Diffuser with 1" Regressed (standard)

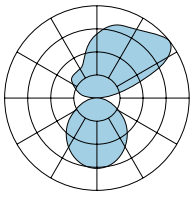
OPTIC OPTIONS

Widespread & Widespread Top Glow (**WSO / WSO-TG**)



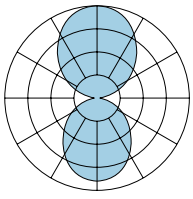
Downlight Spread Optic (**DSO**)

Asymmetric & Asymmetric Top Glow (**ASY / ASY-TG**)



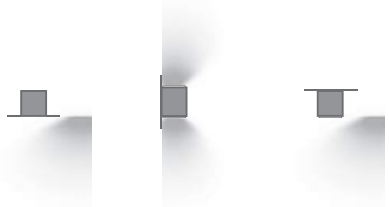
Standard Downlight Flush Optic (**F**)

Standard Uplight Flush Optic (**F**)



Standard Downlight Flush Optic (**F**)

ALSO AVAILABLE IN



Recessed (**R**)

Wall Mount (**WM**)

Surface Mount (**SM**)

Option Available

Finelite, Inc. • 30500 Whipple Road • Union City • CA 94587-1530 • P: 510-441-1100 • F: 510-441-1510 • www.finelite.com.

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18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 133
H+B

Submitted by:	Date:
Type:	Project:
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FINELITE®
Better Lighting

High Performance 4" Aperture (HP-4) Pendant

L14A orm

Refer to lengths indicated on plan

OUTPUT AND LED TYPE

Platform	Series Name	Luminaire Type	Luminaire Distribution	Total Length of Run	Uplight Output ID & I Only (Flush)	Downlight Output ID & D Only (Flush)
◉ HP - High Performance	◉ 4	◯ P - Pendant ◯ P RG - Pendant Regressed [1] (Wall Wash not available)	◯ D - Direct ◯ WW-D - Wall Wash Direct ◯ ID - Indirect/Direct ◯ I - Indirect	_____ Minimum 2' section length. Increments accurate to 1/16" (±1/32"), standard. 12' maximum section length.	◯ S - Standard (428 lm/ft) ◯ B - Boosted (538 lm/ft) ◯ H - High (813 lm/ft) ◯ V - Very High (1045 lm/ft) ◯ TL - Tailored:_____lm/ft*	◯ S - Standard (379 lm/ft) ◯ B - Boosted (477 lm/ft) ◯ H - High (721 lm/ft) ◯ V - Very High (927 lm/ft) ◯ TL - Tailored:_____m/ft*

* Specify lm/ft of outputs between Standard (S) and Very High (V). Consult factory for tailored lumen output outside of this range.

OUTPUT AND LED TYPE

LED CRI/CCT
◯ 830 - 80 CRI, 3000K
◯ 835 - 80 CRI, 3500K
◯ 840 - 80 CRI, 4000K
◯ 930 - 90 CRI, 3000K
◯ 935 - 90 CRI, 3500K
◯ 940 - 90 CRI, 4000K
◯ 8TW - 80 CRI, Tunable White
◯ 9TW - 90 CRI, Tunable White

MECHANICAL/OPTICAL OPTIONS

Uplight Optics ID & I Only	Downlight Optics ID & D Only	Reflector System
◯ TG - Top Glow (standard) ◯ F - Flush ◯ WSO - Widespread Optic ◯ WSOTG - Widespread Optic with Top Glow ◯ ASY-L - Asymmetric Left Optic ◯ ASY-R - Asymmetric Right Optic ◯ ASYTG-L - Asymmetric Left Optic with Top Glow ◯ ASYTG-R - Asymmetric Right Optic with Top Glow	◯ F - Flush (standard) [2] ◯ BG - Bottom Glow [2] ◯ DL - 1" Drop Down Lens [2] ◯ RG-D - Flat Diffuser with 1" Regress [2,3] ◯ RG-WCB - White Cross Blade Baffle [2,3] ◯ RG-LHE - Hollowed Ellipse Louver [2,3] ◯ RG-LHC - Hex Louver [2,3] ◯ DSO - Downlight Spread Optic [4] ◯ K - Kicker for Wall Wash only (standard) ◯ FO - Fully Open for Wall Wash only	◯ 96LG - 96 Low Gloss White ◯ SSA - Semi-Specular Aluminum for Wall Wash only

ELECTRICAL OPTIONS

Voltage
◯ 120 - 120 Voltage
◯ 277 - 277 Voltage
◯ 347 - 347 Voltage

ELECTRICAL OPTIONS

Circuiting [5]
◯ SC - Single Circuit* One single circuit in a run
◯ DC - Dual Circuit* [6] Independent control of up and down separately in an I/D style fixture
◯ MC - Multi-Circuit* More than one switch leg or zone. Factory shop drawings required

* Battery, Night Light, and Emergency to Generator circuits are in addition to the normal luminaire circuit(s)

Driver Selection
0-10V Driver Options
◯ FC-10% - 0-10V 10% [7] (standard)
◯ FC-1% - 0-10V 1% [7]
◯ OSR-10% - Osram OTi, 0-10V 10% [7]
◯ OSR-1% - Osram OTi, 0-10V 1% [7]
◯ ELD-10V-0% - EldoLED SOLOdrive, 0-10V 0.1%
◯ OSR-10V-TW - Osram OTi, 0-10V 10% *(Tunable White)* [7]
DALI Driver Options
◯ FC-DALI-1% - DALI 1%
◯ OSR-DALI-1% - Osram Dexal, 1%
◯ ELD-DALI-0% - EldoLED SOLOdrive, 0.1%
◯ ELD-DALI-TW - EldoLED DUALdrive LightShape, 0.1% *(Tunable White)*
DMX Driver Options
◯ FIN-DMX - Finelite DMX 1% *(Tunable White - FineTune Controls Only)* [8]
◯ ELD-DMX - EldoLED POWERdrive, 0.1%
◯ ELD-DMX-TW - EldoLED POWERdrive, 0.1% *(Tunable White)*
Lutron Driver Options
◯ LUT-ES1 - Lutron, Ecosystem 1%
◯ LUT-2W - Lutron, 2-wire (120V only) 1%
◯ LUT-TW - Lutron T-Series, EcoSystem 0.1% *(Tunable White)*
See Page 3 for additional driver options and details

MOUNTING OPTIONS

Mounting Method
◯ FA50 - Fully Adjustable 50" (standard)
◯ FA100 - Fully Adjustable 100"
◯ FA150 - Fully Adjustable 150"
◯ FA200 - Fully Adjustable 200"
◯ FA250 - Fully Adjustable 250"
◯ FA300 - Fully Adjustable 300"
◯ FM - Flexible Mounting [9]

MOUNTING OPTIONS

Ceiling Hardware Type
◯ C1 - 1" T-Bar
◯ C2 - 9/16" T-Bar
◯ C3 - Screw Slot
◯ C4 - Hard Ceiling

OTHER OPTIONS

Endcap Style	Finish	Emergency Style (Optional)	Integrated Sensor (Optional)	Special Options (Optional)
◯ FE - Flat Endcap (standard) ◯ DE - 1" Drop Endcap [10] ◯ OE - Open Endcap [11]	◯ SW - Signal White (standard) ◯ FB - Finelite Black [12] ◯ SA - Satin Aluminum [12] ◯ #### - RAL Color Code [12] _____	◯ FAC CHO - Factory Choice Battery Back-up ◯ EM/GEN - Emergency to Generator ◯ NL - Night Light ◯ BSL722 - Bodine Battery Back up ◯ BSL310LP - Bodine Battery Back up Low Profile ◯ GTD - Generator Transfer Device	◯ OBO - Occupancy [2] ◯ OBD - Daylight [2] ◯ OBE - Enlighted [13] ◯ REE - Remote Enlighted [14]	◯ CP - Chicago Plenum [15] ◯ RLA - Red List Approved ◯ RLD - Declared

AS INDICATED ON PLAN

[1] Not available with Indirect
[2] Not available with Wall Wash
[3] Pendant Regressed only
[4] Not available with Regressed or Curves
[5] Contact factory for switching options
[6] Indirect/Direct only
[7] Add DTO to gain "Dim to Off" functionality (FC-10% - DTO)
[8] B & V outputs only
[9] Direct only
[10] 1" Drop Down Lens downlight only
[11] Available with Hollowed Ellipse Louver (**LHE**) only
[12] 20 business days lead time for color
[13] Enlighted components installed by Finelite, provided by others
[14] Enlighted for Wall Wash fixtures. Enlighted Control Unit & Sensor Cable installed for Remote mounting sensor
[15] Only available with C1, C2, and C3 mounting hardware with Finelite Gridbox

Submitted by:		Date:
Type:	Project:	
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FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Pendant L14A

SUPPLEMENTARY DRIVER PAGE

0-10V Driver Options	
FC-10%	Factory Choice, 0-10V 10% Dimming (Linear)
FC-10%-DTO	Factory Choice, 0-10V 10% Dimming, Dim-to-Off (Linear)
FC-1%	Factory Choice, 0-10V 1% Dimming (Linear)
FC-1%-DTO	Factory Choice, 0-10V 1% Dimming, Dim-to-Off (Linear)
ELD-10V-0%	EldoLED SOLOdrive, 0-10V 0.1% Dimming (Linear)
ELD-10V-1%	EldoLED ECOdrive, 0-10V 1% Dimming (Linear)
OSR-10V-TW	Osram OTi, 0-10V 10% Dimming, *Tunable White* (Linear)
OSR-10V-TW-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off, *Tunable White* (Linear)
OSR-10%	Osram OTi, 0-10V 10% Dimming (Linear)
OSR-10%-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off (Linear)
OSR-1%	Osram OTi, 0-10V 1% Dimming (Linear)
OSR-1%-DTO	Osram OTi, 0-10V 1% Dimming, Dim-to-Off (Linear)

DALI Driver Options	
FC-DALI-1%	Factory Choice, DALI 1% Dimming (Logarithmic)
OSR-DALI-1%	Osram Dexal, DALI 1% Dimming (Logarithmic)
ELD-DALI-0%	EldoLED SOLOdrive, DALI 0.1% Dimming (Logarithmic)
ELD-DALI-1%	EldoLED ECOdrive, DALI 1% Dimming (Logarithmic)
ELD-DALI-TW	EldoLED DUALdrive Light Shape, DALI 0.1% Dimming, *Tunable White* (Logarithmic Dimming, Linear CCT Control)

DMX Driver Options	
FIN-DMX	Finelite, DMX 1% Dimming, *Tunable White* - **FineTUNE Controls Only** (Linear)
ELD-DMX	EldoLED POWERdrive, DMX 0.1% Dimming (8 Bit, 1CH) (Linear)
ELD-DMX-16	EldoLED POWERdrive, DMX 0.1% Dimming (16 Bit, 2CH) (Linear)
ELD-DMX-TW	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (8 Bit, 2CH - CH1 Warm / CH2 Cool) (Linear)
ELD-DMX-TW16	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (16 Bit, 4CH - CH1, 2 Warm / CH3, 4 Cool) (Linear)

Lutron Driver Options	
LUT-ES1	Lutron, Ecosystem 1% Dimming
LUT-2W	Lutron, 2-wire (120V only) 1% Dimming
LUT-TW	Lutron T-Series, EcoSystem 0.1% Dimming, *Tunable White*

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Pendant L14A

SPECIFICATIONS

BODY TYPE

CONSTRUCTION: Precision-cut 6061-T6 extruded aluminum body. Internal joiner system, plug-together wiring, standard.

LENGTHS: Any length, 2' minimum, in increments down to 1/16" (±1/32"). 12' maximum section length. Hollowed Ellipse Louver (**LHE**), Hex Louver (**LHC**), and White Cross Blade Baffle (**WCB**) are available in 1' increments.

MITERED CORNERS[1]**:** Illuminated corners of greater than 60° and less than 180° in a single plane, available with Flush Diffuser, Bottom Glow Diffuser, 1" Drop Down Lens[2], Regressed Diffuser, or White Cross Blade Baffle[3]. Corners not available with Wall Wash (**WW-D**), Hollowed Ellipse Louver (**LHE**) or Hex Louver (**LHC**). Consult factory for tailored lighting options.

OUTPUT AND LED TYPE

LIGHT OUTPUT: Four lumen packages available, Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). For lengths 3' and greater, the uplight and downlight can be specified with different lumen packages and dual controls. For Tailored Outputs outside of range from Standard (**S**) to Very High (**V**), consult factory. Light engines are replaceable.

MECHANICAL/OPTICAL OPTIONS

UPLIGHT OPTION[4]**:** Patented Top Glow frost white diffuser standard. 12 ft. maximum diffuser length. 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination options include: Flush frost white snap-in diffuser, 73% transmissive, 99% diffusion; Widespread Optic (**WSO**) and Widespread Optic with Top Glow (**WSOTG**); WSO enables increased luminaire spacing with improved ceiling uniformity. Asymmetric optic directs light in a specific direction. **ASY-L** distributes light to the left, **ASY-R** distributed light to the right of the luminaire. Consult factory for more tailored lumen outputs.

DOWNLIGHT OPTION[5]**:** 12' maximum diffuser length. Flush frost white snap-in diffuser standard, 77% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination. Available with Flush (**F**), Bottom Glow (**BG**), 1" Drop Down Lens (**DL**), White Cross Blade Baffle (**WCB**)[6], Hollowed Ellipse Louver (**LHE**)[6], Hex Louver (**LHC**)[6], Downlight Spread Optic (**DSO**), and Regressed downlight diffusers (**RG**)[6]. 1" Drop Down Lens made of acrylic. Available with a solid endcap or an endcap with a diffuse filler to continue the luminous aesthetic. Downlight Spread Optic is an extruded lens with a subtle ribbed appearance providing a batwing distribution for improved optical performance. Consult factory for more tailored lumen outputs.

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

REFLECTORS: Die-formed 20-gauge cold-rolled steel reflectors finished in 96LG High Reflectance white powder coat paint. The standard Semi-Specular Aluminum (**SSA**) Kicker (**K**) reflector delivers light high on the vertical surface. The Kicker reflector can be easily removed for open distribution (**FO**).

ELECTRICAL OPTIONS

STATIC WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed controlling uplight and downlight together (power and dimming). Specify dual feeds for independent control of uplight and downlight. 14-gauge feed used when luminaire current exceeds 5 amps.

TUNABLE WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when fixture current exceeds 5 amps. DMX and power feed at same location (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths.

STATIC WHITE DRIVER: Replaceable 120V, 277V, and 347V constant current reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 100%-10% standard. Dimming to 1% available. Separate dimming for uplight and downlight available. Driver is fully accessible from below the ceiling.

- **Power Factor:** ≥ 0.9
- **Total Harmonic Distortion (THD):** <20%
- **Expected driver lifetime:** 100,000 hours

LUTRON DRIVER OPTIONS:

- **LUT-ES (LDE1)** - (Hi-lume 1% EcoSystem with Soft-On, Fade-to-Black dimming (LDE1 series))
- **LUT-W2 (LTES2W)** - (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)).

TUNABLE WHITE DRIVER: Replaceable LED driver. Driver is accessible from below the ceiling. 120V, 277V, and 347V.

- **Power factor:** ≥0.90
- **Total Harmonic Distortion (THD):** <20%
- **Dimming Range:** 100%-10%
- **Expected driver lifetime.:** 100,000 hours
- **FineTune DMX**: 1%

LUTRON TUNABLE WHITE DRIVER OPTION: LUT-TW (0.1% T-Series 2-Channel Digital Tunable White (PSQ Series)).

[1] Not available with Wall Wash
[2] Indirect/Direct and Direct only
[3] White Cross Blade (WCB) baffles not available with custom angles. Available in 90 degrees only
[4] Pendant Indirect/Direct, Pendant Regressed Indirect/Direct, and Pendant Indirect only
[5] Pendant Indirect/Direct, Pendant Regressed Indirect/Direct, Pendant Direct, and Pendant Regressed Direct only
[6] Pendant Regressed Indirect/Direct & Pendant Regressed Direct only

Continued

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Pendant L14A

SPECIFICATIONS

MOUNTING OPTIONS

HANGING HARDWARE: 50" Fully Adjustable (**FA**) plated steel aircraft cable with safety stop hardware standard. The Flexible Mounting Bracket (**FM**) adjusts the suspension points to accommodate existing architecture. Suspension points adjust up to 2' in from the end of 8' or 12' fixture lengths and up to 1' in on shorter lengths. Consult factory for tailored lighting options.

TUNABLE WHITE DMX HANGING HARDWARE: For grid ceiling applications the dual GridBox™ mounting is supplied (standard). For hard ceiling applications the ceiling mounting box is supplied (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths. Available DMX pendant feed lengths are 5' (standard), 12', and 30'.

TUNABLE WHITE DMX INTERCONNECTION CABLES: Luminaires are pre-wired with plug-and-play interconnection cables to support easy plug-together joining of fixture runs. If a non-FineTune DMX system is specified, a DMX to RJ45 adapter is provided.

OTHER OPTIONS

ENDCAPS: Flat diecast aluminum endcaps (**FE**) add 1/4" to each end of luminaire. 1" Drop Down Lens Endcap (**DE**)[7] includes diffuse element to continue luminance of drop lens. Open Endcap (**OE**) is for use with the Hollowed Ellipse Louver (**LHE**); following the curve of the louver.

EMERGENCY STYLE: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, step-dimming driver, backup battery.

Backup Battery

	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-P-D			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'
HP4-P-WW-D			
Min. Housing Length	8'*	4'*	4'*
EM Lumen Output	2000	1189	2000
EM Section Illum.	4'	4'	4'

* Minimum fixture housing length for battery pack approved without sensor

Backup Battery * Minimum fixture housing length for battery pack approved without sensor

	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-P-ID			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'
HP4-P-I			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	2057	1222	2057
EM Section Illum.	2'	2' or 4'	2'

TUNABLE WHITE ELECTRICAL OPTIONS[8]:
– **TW Driver Options 0-10V:** EM/GEN, GTD or Battery Back up
– **FineTune DMX:** EM/GEN or Battery Back up
– **DMX:** Battery Back up
– **DALI:** EM/GEN, GTD or Battery Back up
– **LUTRON:** EM/GEN, GTD or Battery Back up

INTEGRATED SENSORS: Integrated PIR (Passive Infrared) occupancy or daylight sensors available with Flush and Bottom Glow downlight diffusers. Refer to Occupancy Sensor and Daylight Sensor tech sheets for more info.

FINISHES: Finelite Signal White (**SW**) powder coat, Finelite Black (RAL 9005) with semi gloss fine texture (**FB**)[9], and Satin Aluminum (**SA**)[9] are standard. Optional Adder: 185 RAL colors[9] are available.

LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.130 (G), this luminaire contains an internal driver disconnect. UL 924 and UL 2108 - PoE options available on request. These fixtures are rated for Damp Location. Chicago Plenum options available for C1, C2, or C3 suspension using our GridBox. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2015/863. Consult factory for tailored lighting options. Finelite makes the specification process easy when putting healthier products on your projects. Simply add – **RLA** (Red List Approved) or – **RLD** (Declared Label) to your part number.

WEIGHT[10]: ID - 3.4 lb/ft; D - 2.8 lb/ft; I - 2.8 lb/ft; WW - 2.9 lb/ft

DLC QUALIFIED: Configurations of this product are listed on the DLC Qualified Products List (QPL). www.designlights.org/search

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

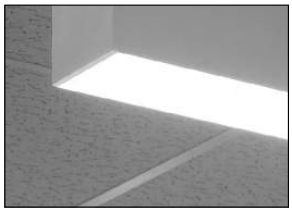
[7] Available in Indirect/Direct Regressed & Direct Regressed only
[8] Consult Finelite for Generator Transfer Device and Battery Backup fit
[9] 20 business days lead time for color
[10] Excludes Battery Backup and Generator Transfer Device weight

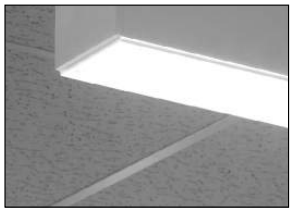
Submitted by:		Date:
Type:	Project:	
Ordering Info:		

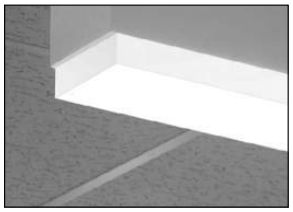
FINELITE® Better Lighting

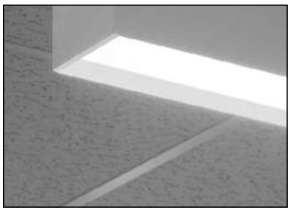
High Performance 4" Aperture (HP-4) Pendant L14A

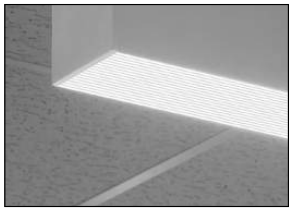
AESTHETIC OPTIONS

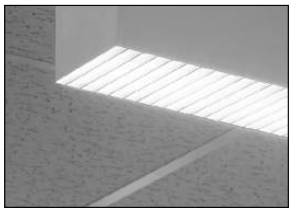

Flush Diffuser (**F**)

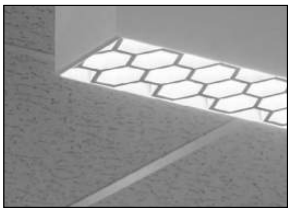

Bottom Glow Diffuser (**BG**)

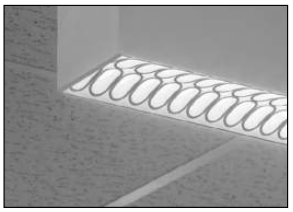

1" Drop Down Lens (**DL**)

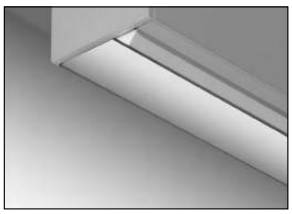

Flat Diffuser with 1" Regressed (**RG-D**)


Downlight Spread Optic (**DSO**)
Externally flush


White Cross Blade Baffle [1] (**RG-WCB**)


Hex Louver [1] (**RG-LHC**)

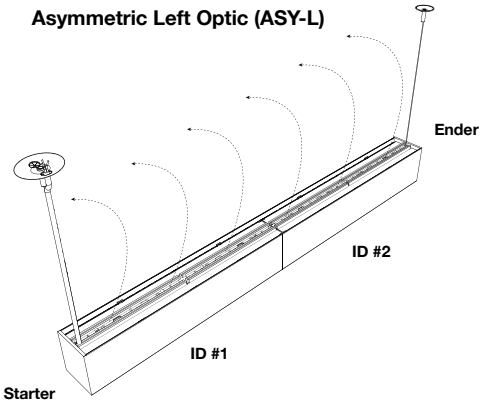

Hollowed Ellipse Louver [1] (**RG-LHE**)


Kicker (**K**) - Wall Wash only

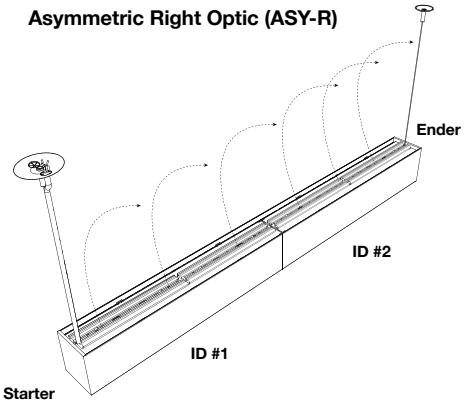
ASYMMETRIC OPTIONS

Use this tool to understand how to specify Asymmetric for your project. The diagrams below show a linear run from power feed to ender. Specify ASY-L distributes light to the left or ASY-R distributes light to the right.

Asymmetric Left Optic (ASY-L)



Asymmetric Right Optic (ASY-R)



[1] Available for Regressed

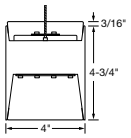
Submitted by:	Date:
Type:	Project:
Ordering Info:	

FINELITE® Better Lighting

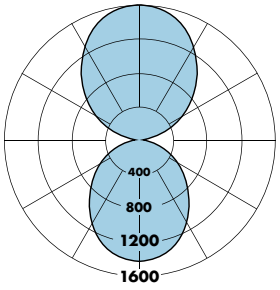
High Performance 4" Aperture (HP-4) Pendant L14A

Indirect/Direct Photometry - 4' Luminaire 3500K

HP4-P-ID-4'-V-V-835
Uplight: Flush Diffuser / **Downlight:** Flush Diffuser



Distribution: 53% Up (**V**) / 47% Down (**V**)
Efficacy: 106 lm/W
Uplight: 4180 lumens (1045 lumens/foot)
Downlight: 3706 lumens (927 lumens/foot)
Total luminaire output: 7886 lumens (1972 lm/ft)
74.1 watts (18.5 W/ft)
Peak Candela Value: 1600 @ 180°
CRI: 80 / CCT: 3500K
ITL LM79 Report 85125



CANDELA DISTRIBUTION

	0.0	22.5	45	67.5	90	Flux
0	1443	1443	1443	1443	1443	
5	1433	1434	1434	1433	1434	136
15	1368	1360	1365	1363	1356	384
25	1239	1225	1228	1224	1216	564
35	1062	1050	1049	1040	1034	654
45	859	850	847	838	832	652
55	647	640	637	628	624	568
65	435	430	429	424	422	424
75	233	234	233	234	232	248
85	65	67	68	69	70	76
90	0	0	0	0	0	
95	71	72	76	81	82	86
105	257	261	266	270	269	281
115	485	483	485	490	486	482
125	723	726	726	720	717	646
135	963	958	961	958	951	739
145	1189	1177	1185	1179	1172	738
155	1377	1367	1374	1368	1363	631
165	1517	1510	1514	1511	1510	426
175	1590	1590	1590	1589	1590	151
180	1600	1600	1600	1600	1600	

Complete LM79 LED Photometry

Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire				
	↑S [1]	↑B [1]	↑H [1]	↑V [2]
↓S [1]	3228 (↑53% I 47%↓)	3668 (↑59% I 41%↓)	4768 (↑68% I 32%↓)	5697 (↑73% I 27%↓)
↓B [1]	3618 (↑47% I 53%↓)	4058 (↑53% I 47%↓)	5158 (↑63% I 37%↓)	6087 (↑69% I 31%↓)
↓H [1]	4594 (↑37% I 63%↓)	5034 (↑43% I 57%↓)	6134 (↑53% I 47%↓)	7062 (↑59% I 41%↓)
↓V [2]	5417 (↑32% I 68%↓)	5857 (↑37% I 63%↓)	6957 (↑47% I 53%↓)	7886 (↑53% I 47%↓)

Light Output, 3500K, 80 CRI (Lumens Per Foot)				
	↑S [1]	↑B [1]	↑H [1]	↑V [2]
↓S [1]	807	917	1192	1424
↓B [1]	905	1015	1290	1522
↓H [1]	1148	1258	1533	1766
↓V [2]	1354	1464	1739	1972

Power, 3500K (Watts Per Foot)				
	↑S [1]	↑B [1]	↑H [1]	↑V [2]
↓S [1]	7.3	8.2	10.7	12.9
↓B [1]	8.2	9.2	11.7	13.9
↓H [1]	10.7	11.7	14.2	16.4
↓V [2]	12.9	13.9	16.4	18.5

Efficacy, 3500K, 80 CRI (Lumens Per Watt)				
	↑S [1]	↑B [1]	↑H [1]	↑V [2]
↓S [1]	111	111	111	111
↓B [1]	110	110	110	110
↓H [1]	107	107	108	108
↓V [2]	105	106	106	106

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output

[1] Family Correlation based on 4' luminaire 3500K Very High Output (**V**) test - 120V.
[2] Based on ITL report: 89125

Sample Lumen Adjustment Calculation

Lumen Adjustment Factors 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

Lumen Adjustment Factors 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

High Output (**H**) / Standard Output (**S**), 4000K, 90 CRI

Lumen Adjustment Factor: 0.789

Total Light Output: 4768 lm x 0.789 = 3762 lm

Total Light Output per Foot: 1192 lm/ft x 0.789 = 940 lm/ft.

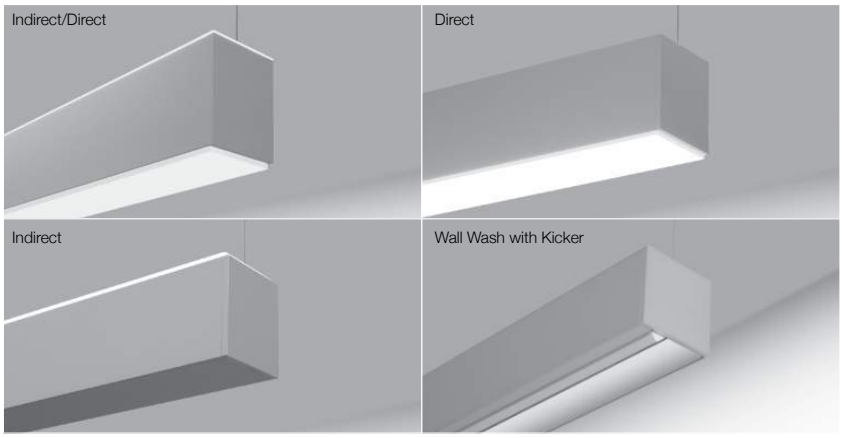
watts/foot: 10.7 W/ft.

Efficacy = $\frac{940 \frac{\text{lm}}{\text{ft.}}}{10.7 \frac{\text{W}}{\text{ft.}}}$ = 88 lm/W

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Pendant L14B



Signal White is standard finish

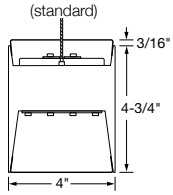
Note: see page 6 for all aesthetic options

High Performance 4" Aperture is a patented, linear LED luminaire family. HP-4 delivers excellent performance using an advanced optical design and mid-power LEDs. Achieving 90% of initial light output at 100,000+ hours and backed by a 10-year performance-based warranty on all standard components.

This product is enrolled in the International Living Future Institute (ILFI) Declare 2.0 Program and is third-party verified with options achieving **Red List Approved** and **Declared** status.

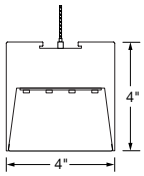
CROSS SECTIONS

Indirect/Direct
Top Glow Diffuser (standard)



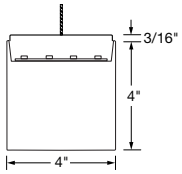
Flush Downlight Diffuser (standard)

Direct

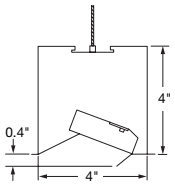


Flush Downlight Diffuser (standard)

Indirect
Top Glow Diffuser (standard)

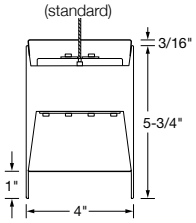


Wall Wash Direct



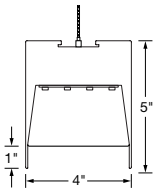
Kicker (standard)

Regressed Indirect/Direct
Top Glow Diffuser (standard)



Flat Diffuser with 1" Regressed (standard)

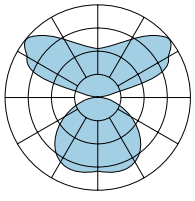
Regressed Direct



Flat Diffuser with 1" Regressed (standard)

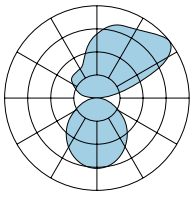
OPTIC OPTIONS

Widespread & Widespread Top Glow (**WSO / WSO-TG**)



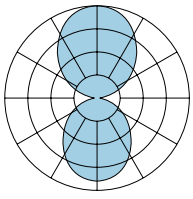
Downlight Spread Optic (**DSO**)

Asymmetric & Asymmetric Top Glow (**ASY / ASY-TG**)



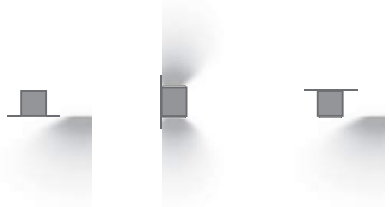
Standard Downlight Flush Optic (**F**)

Standard Uplight Flush Optic (**F**)



Standard Downlight Flush Optic (**F**)

ALSO AVAILABLE IN



Recessed (**R**)

Wall Mount (**WM**)

Surface Mount (**SM**)

Option Available

Protected by one or more US Patents: 8915613; D702,391; D702,390; D700,732

A brand of legrand®

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 140
H+B

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Pendant

L14B orm

BODY TYPE

Platform	Series Name	Luminaire Type	Luminaire Distribution	Total Length of Run
◉ HP - High Performance	◉ 4	◯ P - Pendant ◯ P RG - Pendant Regressed [1] (Wall Wash not available)	◯ D - Direct ◯ WW-D - Wall Wash Direct ◯ ID - Indirect/Direct ◯ I - Indirect	12FT Minimum 2' section length. Increments accurate to 1/16" (±1/32"), standard. 12' maximum section length.

OUTPUT AND LED TYPE

Uplight Output ID & I Only (Flush)	Downlight Output ID & D Only (Flush)
◯ S - Standard (428 lm/ft)	◯ S - Standard (379 lm/ft)
◯ B - Boosted (538 lm/ft)	◯ B - Boosted (477 lm/ft)
◯ H - High (813 lm/ft)	◯ H - High (721 lm/ft)
◯ V - Very High (1045 lm/ft)	◯ V - Very High (927 lm/ft)
◯ TL - Tailored:_____lm/ft*	◯ TL - Tailored:_____m/ft*

* Specify lm/ft of outputs between Standard (S) and Very High (V). Consult factory for tailored lumen output outside of this range.

OUTPUT AND LED TYPE

LED CRI/CCT
◯ 830 - 80 CRI, 3000K
◯ 835 - 80 CRI, 3500K
◯ 840 - 80 CRI, 4000K
◯ 930 - 90 CRI, 3000K
◯ 935 - 90 CRI, 3500K
◯ 940 - 90 CRI, 4000K
◯ 8TW - 80 CRI, Tunable White
◯ 9TW - 90 CRI, Tunable White

MECHANICAL/OPTICAL OPTIONS

Uplight Optics ID & I Only	Downlight Optics ID & D Only	Reflector System
◯ TG - Top Glow (standard)	◯ F - Flush (standard) [2]	◯ 96LG - 96 Low Gloss White
◯ F - Flush	◯ BG - Bottom Glow [2]	◯ SSA - Semi-Specular Aluminum for Wall Wash only
◯ WSO - Widespread Optic	◯ DL - 1" Drop Down Lens [2]	
◯ WSOTG - Widespread Optic with Top Glow	◯ RG-D - Flat Diffuser with 1" Regress [2,3]	
◯ ASY-L - Asymmetric Left Optic	◯ RG-WCB - White Cross Blade Baffle [2,3]	
◯ ASY-R - Asymmetric Right Optic	◯ RG-LHE - Hollowed Ellipse Louver [2,3]	
◯ ASYTG-L - Asymmetric Left Optic with Top Glow	◯ RG-LHC - Hex Louver [2,3]	
◯ ASYTG-R - Asymmetric Right Optic with Top Glow	◯ DSO - Downlight Spread Optic [4]	
	◯ K - Kicker for Wall Wash only (standard)	
	◯ FO - Fully Open for Wall Wash only	

ELECTRICAL OPTIONS

Voltage
◯ 120 - 120 Voltage
◯ 277 - 277 Voltage
◯ 347 - 347 Voltage

ELECTRICAL OPTIONS

Circuiting [5]
◯ SC - Single Circuit* One single circuit in a run
◯ DC - Dual Circuit* [6] Independent control of up and down separately in an I/D style fixture
◯ MC - Multi-Circuit* More than one switch leg or zone. Factory shop drawings required
* Battery, Night Light, and Emergency to Generator circuits are in addition to the normal luminaire circuit(s)

Driver Selection
0-10V Driver Options
◯ FC-10% - 0-10V 10% [7] (standard)
◯ FC-1% - 0-10V 1% [7]
◯ OSR-10% - Osram OTi, 0-10V 10% [7]
◯ OSR-1% - Osram OTi, 0-10V 1% [7]
◯ ELD-10V-0% - EldoLED SOLOdrive, 0-10V 0.1%
◯ OSR-10V-TW - Osram OTi, 0-10V 10% *(Tunable White)* [7]
DALI Driver Options
◯ FC-DALI-1% - DALI 1%
◯ OSR-DALI-1% - Osram Dexal, 1%
◯ ELD-DALI-0% - EldoLED SOLOdrive, 0.1%
◯ ELD-DALI-TW - EldoLED DUALdrive LightShape, 0.1% *(Tunable White)*
DMX Driver Options
◯ FIN-DMX - Finelite DMX 1% *(Tunable White - FineTune Controls Only)* [8]
◯ ELD-DMX - EldoLED POWERdrive, 0.1%
◯ ELD-DMX-TW - EldoLED POWERdrive, 0.1% *(Tunable White)*
Lutron Driver Options
◯ LUT-ES1 - Lutron, Ecosystem 1%
◯ LUT-2W - Lutron, 2-wire (120V only) 1%
◯ LUT-TW - Lutron T-Series, EcoSystem 0.1% *(Tunable White)*
See Page 3 for additional driver options and details

MOUNTING OPTIONS

Mounting Method
◯ FA50 - Fully Adjustable 50" (standard)
◯ FA100 - Fully Adjustable 100"
◯ FA150 - Fully Adjustable 150"
◯ FA200 - Fully Adjustable 200"
◯ FA250 - Fully Adjustable 250"
◯ FA300 - Fully Adjustable 300"
◯ FM - Flexible Mounting [9]

MOUNTING OPTIONS

Ceiling Hardware Type
◯ C1 - 1" T-Bar
◯ C2 - 9/16" T-Bar
◯ C3 - Screw Slot
◯ C4 - Hard Ceiling

OTHER OPTIONS

Endcap Style
◯ FE - Flat Endcap (standard)
◯ DE - 1" Drop Endcap [10]
◯ OE - Open Endcap [11]

Finish
◯ SW - Signal White (standard)
◯ FB - Finelite Black [12]
◯ SA - Satin Aluminum [12]
◯ #### - RAL Color Code [12]
_____
TBD by architect

Emergency Style (Optional)
◯ FAC CHO - Factory Choice Battery Back-up
◯ EM/GEN - Emergency to Generator
◯ NL - Night Light
◯ BSL722 - Bodine Battery Back up
◯ BSL310LP - Bodine Battery Back up Low Profile
◯ GTD - Generator Transfer Device

Integrated Sensor (Optional)
◯ OBO - Occupancy [2]
◯ OBD - Daylight [2]
◯ OBE - Enlighted [13]
◯ REE - Remote Enlighted [14]
AS INDICATED ON PLAN

Special Options (Optional)
◯ CP - Chicago Plenum [15]
◯ RLA - Red List Approved
◯ RLD - Declared

[1] Not available with Indirect
[2] Not available with Wall Wash
[3] Pendant Regressed only
[4] Not available with Regressed or Curves
[5] Contact factory for switching options
[6] Indirect/Direct only
[7] Add DTO to gain "Dim to Off" functionality (FC-10% - DTO)
[8] B & V outputs only
[9] Direct only
[10] 1" Drop Down Lens downlight only
[11] n Hollowed Ellipse Louver (**LHE**) only
[12] 20 business days lead time for color
[13] Enlighted components installed by Finelite, provided by others
[14] Enlighted for Wall Wash fixtures. Enlighted Control Unit & Sensor Cable installed for Remote mounting sensor
[15] Only available with C1, C2, and C3 mounting hardware with Finelite Gridbox

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Pendant L14B

SUPPLEMENTARY DRIVER PAGE

0-10V Driver Options	
FC-10%	Factory Choice, 0-10V 10% Dimming (Linear)
FC-10%-DTO	Factory Choice, 0-10V 10% Dimming, Dim-to-Off (Linear)
FC-1%	Factory Choice, 0-10V 1% Dimming (Linear)
FC-1%-DTO	Factory Choice, 0-10V 1% Dimming, Dim-to-Off (Linear)
ELD-10V-0%	EldoLED SOLOdrive, 0-10V 0.1% Dimming (Linear)
ELD-10V-1%	EldoLED ECOdrive, 0-10V 1% Dimming (Linear)
OSR-10V-TW	Osram OTi, 0-10V 10% Dimming, *Tunable White* (Linear)
OSR-10V-TW-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off, *Tunable White* (Linear)
OSR-10%	Osram OTi, 0-10V 10% Dimming (Linear)
OSR-10%-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off (Linear)
OSR-1%	Osram OTi, 0-10V 1% Dimming (Linear)
OSR-1%-DTO	Osram OTi, 0-10V 1% Dimming, Dim-to-Off (Linear)

DALI Driver Options	
FC-DALI-1%	Factory Choice, DALI 1% Dimming (Logarithmic)
OSR-DALI-1%	Osram Dexal, DALI 1% Dimming (Logarithmic)
ELD-DALI-0%	EldoLED SOLOdrive, DALI 0.1% Dimming (Logarithmic)
ELD-DALI-1%	EldoLED ECOdrive, DALI 1% Dimming (Logarithmic)
ELD-DALI-TW	EldoLED DUALdrive Light Shape, DALI 0.1% Dimming, *Tunable White* (Logarithmic Dimming, Linear CCT Control)

DMX Driver Options	
FIN-DMX	Finelite, DMX 1% Dimming, *Tunable White* - **FineTUNE Controls Only** (Linear)
ELD-DMX	EldoLED POWERdrive, DMX 0.1% Dimming (8 Bit, 1CH) (Linear)
ELD-DMX-16	EldoLED POWERdrive, DMX 0.1% Dimming (16 Bit, 2CH) (Linear)
ELD-DMX-TW	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (8 Bit, 2CH - CH1 Warm / CH2 Cool) (Linear)
ELD-DMX-TW16	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (16 Bit, 4CH - CH1, 2 Warm / CH3, 4 Cool) (Linear)

Lutron Driver Options	
LUT-ES1	Lutron, Ecosystem 1% Dimming
LUT-2W	Lutron, 2-wire (120V only) 1% Dimming
LUT-TW	Lutron T-Series, EcoSystem 0.1% Dimming, *Tunable White*

Submitted by:	Date:
Type:	Project:
Ordering Info:	

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Pendant L14B

SPECIFICATIONS

BODY TYPE

CONSTRUCTION: Precision-cut 6061-T6 extruded aluminum body. Internal joiner system, plug-together wiring, standard.

LENGTHS: Any length, 2' minimum, in increments down to 1/16" (±1/32"). 12' maximum section length. Hollowed Ellipse Louver (**LHE**), Hex Louver (**LHC**), and White Cross Blade Baffle (**WCB**) are available in 1' increments.

MITERED CORNERS[1]**:** Illuminated corners of greater than 60° and less than 180° in a single plane, available with Flush Diffuser, Bottom Glow Diffuser, 1" Drop Down Lens[2], Regressed Diffuser, or White Cross Blade Baffle[3]. Corners not available with Wall Wash (**WW-D**), Hollowed Ellipse Louver (**LHE**) or Hex Louver (**LHC**). Consult factory for tailored lighting options.

OUTPUT AND LED TYPE

LIGHT OUTPUT: Four lumen packages available, Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). For lengths 3' and greater, the uplight and downlight can be specified with different lumen packages and dual controls. For Tailored Outputs outside of range from Standard (**S**) to Very High (**V**), consult factory. Light engines are replaceable.

MECHANICAL/OPTICAL OPTIONS

UPLIGHT OPTION[4]**:** Patented Top Glow frost white diffuser standard. 12 ft. maximum diffuser length. 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination options include: Flush frost white snap-in diffuser, 73% transmissive, 99% diffusion; Widespread Optic (**WSO**) and Widespread Optic with Top Glow (**WSOTG**); WSO enables increased luminaire spacing with improved ceiling uniformity. Asymmetric optic directs light in a specific direction. **ASY-L** distributes light to the left, **ASY-R** distributed light to the right of the luminaire. Consult factory for more tailored lumen outputs.

DOWNLIGHT OPTION[5]**:** 12' maximum diffuser length. Flush frost white snap-in diffuser standard, 77% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination. Available with Flush (**F**), Bottom Glow (**BG**), 1" Drop Down Lens (**DL**), White Cross Blade Baffle (**WCB**)[6], Hollowed Ellipse Louver (**LHE**)[6], Hex Louver (**LHC**)[6], Downlight Spread Optic (**DSO**), and Regressed downlight diffusers (**RG**)[6]. 1" Drop Down Lens made of acrylic. Available with a solid endcap or an endcap with a diffuse filler to continue the luminous aesthetic. Downlight Spread Optic is an extruded lens with a subtle ribbed appearance providing a batwing distribution for improved optical performance. Consult factory for more tailored lumen outputs.

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

REFLECTORS: Die-formed 20-gauge cold-rolled steel reflectors finished in 96LG High Reflectance white powder coat paint. The standard Semi-Specular Aluminum (**SSA**) Kicker (**K**) reflector delivers light high on the vertical surface. The Kicker reflector can be easily removed for open distribution (**FO**).

ELECTRICAL OPTIONS

STATIC WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed controlling uplight and downlight together (power and dimming). Specify dual feeds for independent control of uplight and downlight. 14-gauge feed used when luminaire current exceeds 5 amps.

TUNABLE WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when fixture current exceeds 5 amps. DMX and power feed at same location (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths.

STATIC WHITE DRIVER: Replaceable 120V, 277V, and 347V constant current reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 100%-10% standard. Dimming to 1% available. Separate dimming for uplight and downlight available. Driver is fully accessible from below the ceiling.
- **Power Factor:** ≥ 0.9
- **Total Harmonic Distortion (THD):** <20%
- **Expected driver lifetime:** 100,000 hours

LUTRON DRIVER OPTIONS:
- **LUT-ES (LDE1)** - (Hi-lume 1% EcoSystem with Soft-On, Fade-to-Black dimming (LDE1 series))
- **LUT-W2 (LTES2W)** - (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)).

TUNABLE WHITE DRIVER: Replaceable LED driver. Driver is accessible from below the ceiling. 120V, 277V, and 347V.
- **Power factor:** ≥0.90
- **Total Harmonic Distortion (THD):** <20%
- **Dimming Range:** 100%-10%
- **Expected driver lifetime.:** 100,000 hours
- **FineTune DMX**: 1%

LUTRON TUNABLE WHITE DRIVER OPTION: LUT-TW (0.1% T-Series 2-Channel Digital Tunable White (PSQ Series)).

[1] Not available with Wall Wash
[2] Indirect/Direct and Direct only
[3] White Cross Blade (WCB) baffles not available with custom angles. Available in 90 degrees only
[4] Pendant Indirect/Direct, Pendant Regressed Indirect/Direct, and Pendant Indirect only
[5] Pendant Indirect/Direct, Pendant Regressed Indirect/Direct, Pendant Direct, and Pendant Regressed Direct only
[6] Pendant Regressed Indirect/Direct & Pendant Regressed Direct only

Continued

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

High Performance 4" Aperture (HP-4) Pendant L14B

SPECIFICATIONS

MOUNTING OPTIONS

HANGING HARDWARE: 50" Fully Adjustable (**FA**) plated steel aircraft cable with safety stop hardware standard. The Flexible Mounting Bracket (**FM**) adjusts the suspension points to accommodate existing architecture. Suspension points adjust up to 2' in from the end of 8' or 12' fixture lengths and up to 1' in on shorter lengths. Consult factory for tailored lighting options.

TUNABLE WHITE DMX HANGING HARDWARE: For grid ceiling applications the dual GridBox™ mounting is supplied (standard). For hard ceiling applications the ceiling mounting box is supplied (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths. Available DMX pendant feed lengths are 5' (standard), 12', and 30'.

TUNABLE WHITE DMX INTERCONNECTION CABLES: Luminaires are pre-wired with plug-and-play interconnection cables to support easy plug-together joining of fixture runs. If a non-FineTune DMX system is specified, a DMX to RJ45 adapter is provided.

OTHER OPTIONS

ENDCAPS: Flat diecast aluminum endcaps (**FE**) add 1/4" to each end of luminaire. 1" Drop Down Lens Endcap (**DE**)[7] includes diffuse element to continue luminance of drop lens. Open Endcap (**OE**) is for use with the Hollowed Ellipse Louver (**LHE**); following the curve of the louver.

EMERGENCY STYLE: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, step-dimming driver, backup battery.

Backup Battery

	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-P-D			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'
HP4-P-WW-D			
Min. Housing Length	8'*	4'*	4'*
EM Lumen Output	2000	1189	2000
EM Section Illum.	4'	4'	4'

* Minimum fixture housing length for battery pack approved without sensor

Backup Battery * Minimum fixture housing length for battery pack approved without sensor

	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-P-ID			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'
HP4-P-I			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	2057	1222	2057
EM Section Illum.	2'	2' or 4'	2'

TUNABLE WHITE ELECTRICAL OPTIONS[8]:
– **TW Driver Options 0-10V:** EM/GEN, GTD or Battery Back up
– **FineTune DMX:** EM/GEN or Battery Back up
– **DMX:** Battery Back up
– **DALI:** EM/GEN, GTD or Battery Back up
– **LUTRON:** EM/GEN, GTD or Battery Back up

INTEGRATED SENSORS: Integrated PIR (Passive Infrared) occupancy or daylight sensors available with Flush and Bottom Glow downlight diffusers. Refer to Occupancy Sensor and Daylight Sensor tech sheets for more info.

FINISHES: Finelite Signal White (**SW**) powder coat, Finelite Black (RAL 9005) with semi gloss fine texture (**FB**)[9], and Satin Aluminum (**SA**)[9] are standard. Optional Adder: 185 RAL colors[9] are available.

LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.130 (G), this luminaire contains an internal driver disconnect. UL 924 and UL 2108 - PoE options available on request. These fixtures are rated for Damp Location. Chicago Plenum options available for C1, C2, or C3 suspension using our GridBox. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2015/863. Consult factory for tailored lighting options. Finelite makes the specification process easy when putting healthier products on your projects. Simply add – **RLA** (Red List Approved) or – **RLD** (Declared Label) to your part number.

WEIGHT[10]: ID - 3.4 lb/ft; D - 2.8 lb/ft; I - 2.8 lb/ft; WW - 2.9 lb/ft

DLC QUALIFIED: Configurations of this product are listed on the DLC Qualified Products List (QPL). www.designlights.org/search

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

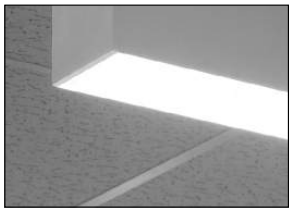
[7] Available in Indirect/Direct Regressed & Direct Regressed only
[8] Consult Finelite for Generator Transfer Device and Battery Backup fit
[9] 20 business days lead time for color
[10] Excludes Battery Backup and Generator Transfer Device weight

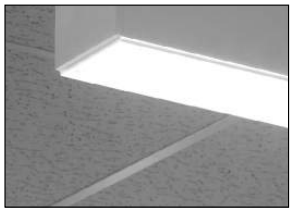
Submitted by:		Date:
Type:	Project:	
Ordering Info:		

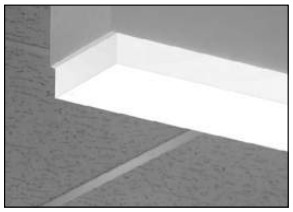
FINELITE® Better Lighting

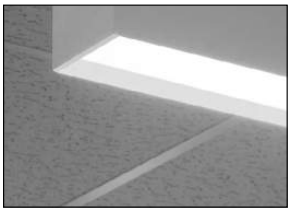
High Performance 4" Aperture (HP-4) Pendant L14B

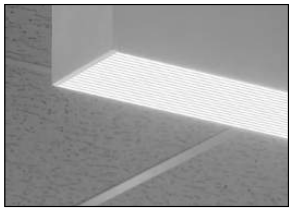
AESTHETIC OPTIONS

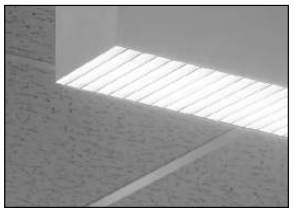

Flush Diffuser (**F**)

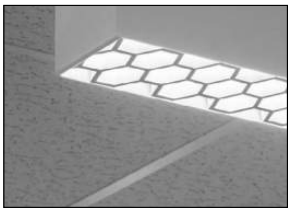

Bottom Glow Diffuser (**BG**)

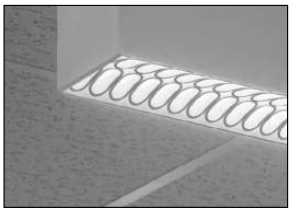

1" Drop Down Lens (**DL**)

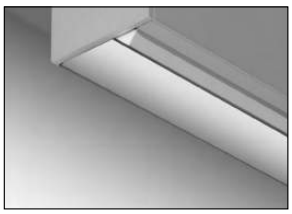

Flat Diffuser with 1" Regressed (**RG-D**)


Downlight Spread Optic (**DSO**)
Externally flush


White Cross Blade Baffle [1] (**RG-WCB**)


Hex Louver [1] (**RG-LHC**)

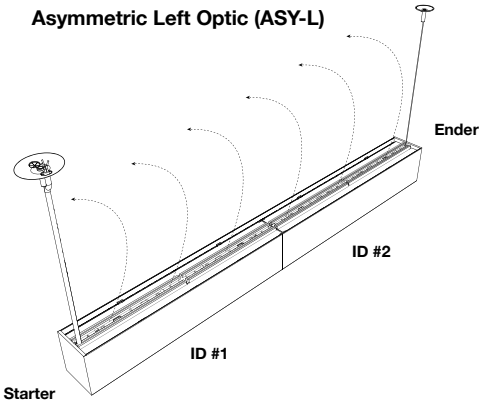

Hollowed Ellipse Louver [1] (**RG-LHE**)


Kicker (**K**) - Wall Wash only

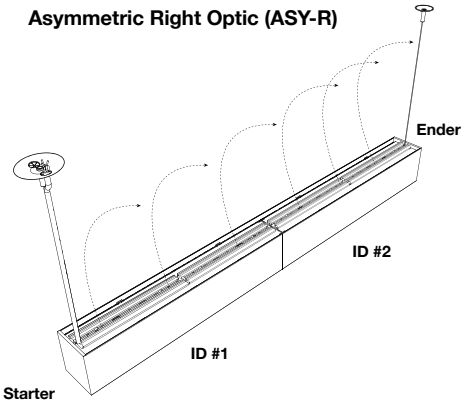
ASYMMETRIC OPTIONS

Use this tool to understand how to specify Asymmetric for your project. The diagrams below show a linear run from power feed to ender. Specify ASY-L distributes light to the left or ASY-R distributes light to the right.

Asymmetric Left Optic (ASY-L)



Asymmetric Right Optic (ASY-R)



[1] Available for Regressed

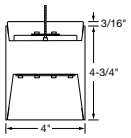
Submitted by:	Date:
Type:	Project:
Ordering Info:	

FINELITE® Better Lighting

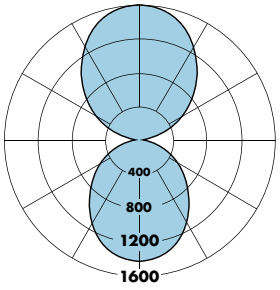
High Performance 4" Aperture (HP-4) Pendant L14B

Indirect/Direct Photometry - 4' Luminaire 3500K

HP4-P-ID-4'-V-V-835
Uplight: Flush Diffuser / **Downlight:** Flush Diffuser



Distribution: 53% Up (**V**) / 47% Down (**V**)
Efficacy: 106 lm/W
Uplight: 4180 lumens (1045 lumens/foot)
Downlight: 3706 lumens (927 lumens/foot)
Total luminaire output: 7886 lumens (1972 lm/ft)
74.1 watts (18.5 W/ft)
Peak Candela Value: 1600 @ 180°
CRI: 80 / CCT: 3500K
ITL LM79 Report 85125



CANDELA DISTRIBUTION

	0.0	22.5	45	67.5	90	Flux
0	1443	1443	1443	1443	1443	
5	1433	1434	1434	1433	1434	136
15	1368	1360	1365	1363	1356	384
25	1239	1225	1228	1224	1216	564
35	1062	1050	1049	1040	1034	654
45	859	850	847	838	832	652
55	647	640	637	628	624	568
65	435	430	429	424	422	424
75	233	234	233	234	232	248
85	65	67	68	69	70	76
90	0	0	0	0	0	
95	71	72	76	81	82	86
105	257	261	266	270	269	281
115	485	483	485	490	486	482
125	723	726	726	720	717	646
135	963	958	961	958	951	739
145	1189	1177	1185	1179	1172	738
155	1377	1367	1374	1368	1363	631
165	1517	1510	1514	1511	1510	426
175	1590	1590	1590	1589	1590	151
180	1600	1600	1600	1600	1600	

Complete LM79 LED Photometry

Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire				
	↑S [1]	↑B [1]	↑H [1]	↑V [2]
↓S [1]	3228 (↑53% I 47%↓)	3668 (↑59% I 41%↓)	4768 (↑68% I 32%↓)	5697 (↑73% I 27%↓)
↓B [1]	3618 (↑47% I 53%↓)	4058 (↑53% I 47%↓)	5158 (↑63% I 37%↓)	6087 (↑69% I 31%↓)
↓H [1]	4594 (↑37% I 63%↓)	5034 (↑43% I 57%↓)	6134 (↑53% I 47%↓)	7062 (↑59% I 41%↓)
↓V [2]	5417 (↑32% I 68%↓)	5857 (↑37% I 63%↓)	6957 (↑47% I 53%↓)	7886 (↑53% I 47%↓)

Light Output, 3500K, 80 CRI (Lumens Per Foot)				
	↑S [1]	↑B [1]	↑H [1]	↑V [2]
↓S [1]	807	917	1192	1424
↓B [1]	905	1015	1290	1522
↓H [1]	1148	1258	1533	1766
↓V [2]	1354	1464	1739	1972

Power, 3500K (Watts Per Foot)				
	↑S [1]	↑B [1]	↑H [1]	↑V [2]
↓S [1]	7.3	8.2	10.7	12.9
↓B [1]	8.2	9.2	11.7	13.9
↓H [1]	10.7	11.7	14.2	16.4
↓V [2]	12.9	13.9	16.4	18.5

Efficacy, 3500K, 80 CRI (Lumens Per Watt)				
	↑S [1]	↑B [1]	↑H [1]	↑V [2]
↓S [1]	111	111	111	111
↓B [1]	110	110	110	110
↓H [1]	107	107	108	108
↓V [2]	105	106	106	106

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output

[1] Family Correlation based on 4' luminaire 3500K Very High Output (**V**) test - 120V.
[2] Based on ITL report: 89125

Sample Lumen Adjustment Calculation

Lumen Adjustment Factors 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

Lumen Adjustment Factors 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

High Output (**H**) / Standard Output (**S**), 4000K, 90 CRI

Lumen Adjustment Factor: 0.789

Total Light Output: 4768 lm x 0.789 = 3762 lm

Total Light Output per Foot: 1192 lm/ft x 0.789 = 940 lm/ft.

watts/foot: 10.7 W/ft.

Efficacy = $\frac{940 \frac{\text{lm}}{\text{ft.}}}{10.7 \frac{\text{W}}{\text{ft.}}}$ = 88 lm/W

HOLOPHANE®
LEADER IN LIGHTING SOLUTIONS

Catalog Number	
Notes	Type L15

Petrolux® LED Low Bay

Hazardous Location for Demanding Environments

PXLH

Description
- For demanding environments with lower mounting heights where dust, dirt and moisture are a concern.
- Certain airborne contaminants may adversely affect the functioning of LEDs and other electronic components, depending on various factors such as concentrations of the contaminants, ventilation, and temperature at the end-user location. Click here for a list of substances that may not be suitable for interaction with LEDs and other electronic components.

Optics
- Prismatic borosilicate glass directs light where needed and reduces harsh glare.
- Silicone rubber lens available that will not brown, chip, shatter or break.
- Four distributions (Type 5 low angle, Type 5 high angle, type 4 forward throw and Type 1 long and narrow) available to maximize versatility.
- Highly engineered LED system ensures superior uniformity and maximizes spacing.
- Lens assembly secured by stainless steel tamper-resistant Torx® T-20 screws.

Electrical
- Luminaire Surge Protection Level: Designed to withstand up to 10kV/5kA per ANSI C82.77-5-2015.
- 0-10V dimming driver is standard.
- 3000K, 4000K or 5000K CCT available.
- Fault-tolerant LED light engine continues to provide light even in the failure of one LED.
- Field Adjustable Output (AO) module - Onboard device that adjusts the light output and input wattage to meet site specific requirements. The AO module is preset at the factory to position number 8 (see chart on page 6).
- Integrated Bluetooth occupancy sensor: The SBG BTP is bluetooth enabled with dimming photocells. Allows you to change settings in the field using the VLP app.

Mechanical
- Super durable TGIC thermoset powder coat. Corrosion resistant finish is a five-stage pre-treating and painting process that yields over 5,000 hours salt rating per ASTM B117.
- Robust cast aluminum housing with low copper content (0.6% CU content) withstands harsh or hostile environments.
- Universal mount high profile top cover (ceiling/pendant). Optional universal arm available for wall/stanchion. Other mountings include a high profile yoke mount.
- Precise number of fins dissipate maximum amount of heat. -40C (-40F) to (149F) ambient rating.
- Universal mount can be wall, stanchion, and angle mounted to accommodate a variety of arms.

Listings
- UL 844
  Class 1, Division 2 Groups A, B, C, D
  Class 2 Division 1 Groups E, F, and G
  Class 2, Division 2 Groups F and G
  Class 3
  Simultaneous presence, Class 1 Division 2, Class 2 Division 1/Class 2 Division 2 (See chart on page 8 for compatibility by nomenclature)
- IP65 and IP66 rated. IP67 rated except when used with the P3US, P3US35 accessories, 07233 substation arms or integral sensors.
- Luminaire is 1G vibration rated.
- NEMA 4X rated (see chart on page 10)
- Marine Rated (see chart on page 10)
- IK rated (see chart on page 6)

Warranty
5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

FIXTURE REQUIRED TO BE DLC LISTED

Typical Applications
- Petroleum refineries
- Ethanol facilities
- Chemical plants
- Power plants
- Textile mills
- Water and wastewater treatment facilities

Dimensions: *Inches (millimeters) unless otherwise noted.*

Universal Mount
Diameter: 13.11 (332.99)
Height: 11.43 (290.32)
Weight: Approx. 19 lbs (8.62 kg)
Pallet quantity: 12 fixtures
EPA: 0.787 sq. ft. wind loading

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 147
H+B

A+ Capable options indicated by this color background.

ORDERING INFORMATION

Example: PXLH 3000LM MDU5 MVOLT 40K 80CRI UNM DGXD

Series	Lumens	Optics	Voltage	Color Temperature	Color Rendering Index	Mounting Options
PXLH	3000LM 3,000 lumens	FWD Forward throw, glass lens	MVOLT (120V-277V)	30K 3000K CCT	70CRI 70CRI	UNM Universal Mount, high profile top cap
	5000LM 5,000 lumens	MD0 Medium, glass lens, with minimal uplight	120 120V	40K 4000K CCT	80CRI 80CRI	PM Pendant Mount, low profile top cap
	8000LM 8,000 lumens	MDU5 Medium, glass lens, with uplight	208 208V	50K 5000K CCT	90CRI 90CRI	YK90 Yoke Mount 0-90 Degree, high profile top cap
	10000LM 10,000 lumens	MDU5FR Medium, frosted glass lens, with uplight	240 240V			
		LND Long and Narrow, glass lens	277 277V			
		SO Medium, silicon optic, with minimal uplight	HVOLT (347V/480V)			
		SOLND Long and Narrow, silicone optic	347 347V			
		WD Wide, glass lens	480 480V			

Options

Cords (No Plug): ‡

CNP16WWL3FT	Cord only, 16-gauge, 3 conductors, white, 3ft
CNP164CWL3FT	Cord only, 16-gauge, 4 conductors, black, 3ft ‡
CNP164CWWL3FT	Cord only, 16-gauge, 4 conductors, white, 3ft ‡
CNP165CDWL3FT	Cord only, 16-gauge, 5 conductors, includes 0-10V dimming leads, black, 3ft
CNP165CDWWL3FT	Cord only, 16-gauge, 5 conductors, includes 0-10V dimming leads, white, 3ft

Mounting Accessories:

072331	Single substation arm ‡
072331CTL	Single substation arm with controls ‡
P3US	Universal mount arm ‡
P3US35	35 Degree Universal Mount Arm ‡

Non -Dimming Sensors:

SBGR10	360° Low Mount Sensor, (8-15' mounting heights), on/off occupancy, IP66 rated (LINK)
SBGR10 P	360° Low Mount Sensor, (8-15' mounting heights), on/off photocell, IP66 rated (LINK)

Dimming Sensors: ‡

SBGR10 D 3V	360° Low Mount sensor, (8-15' mounting heights), high/low occupancy dimming, IP66 rated (LINK)

Bluetooth® Sensors: ‡

SBG10 OCC BTP	360° Low Mount Sensor, (7-15' mounting heights), on/off occupancy, utilizes smart hub for Bluetooth® programmability (LINK)
SBG10 HL BTP	360° Low Mount Sensor, (7-15' mounting heights), high/low/(off) occupancy dimming, utilizes smart hub for Bluetooth® programmability (LINK)
SBG10 ADC BTP	360° Low Mount Sensor, (7-15' mounting heights), on/off occupancy with auto dimming photocell, utilizes smart hub for Bluetooth® programmability (LINK)
SBG10 ANL BTP	360° Low Mount Sensor, (7-15' mounting heights), high/low/(off) occupancy dimming with auto dimming photocell, utilizes smart hub for Bluetooth® programmability (LINK)

XPoint™ Wireless: ‡

XPADS SBG10	Low Mount Sensor, (up to 10' mounting heights), XPoint™ wireless enabled with occupancy and photocell, IP66 rated (LINK)
XAD	XPoint™ Wireless Enabled, single relay, 0-10V dimming, energy monitoring (LINK)
XAD924	XPoint™ Wireless Enabled, single relay, 0-10V dimming, energy monitoring, UL924 EM operation (LINK)

Emergency:

BSL310HAZSB	BSL310HAZ, 10.4W internal hazardous location emergency driver, 0°C min, Certified in CA Title 20 MAEDBS ‡

Other Options:

AO	Field Adjustable Output, Standard setting is 8 ‡
BP	Button style photo control ‡
EMD	Ingress/Egress Marker Decal
NSG	Non Silicone Gasket ‡
UPS	Uplight Shield ‡
USPOM	US Point of Manufacture
WGX	Wire guard, factory installed

Provide for EM lights only

Finish ‡

DGXD	Gray Corrosion Resistant
DWHXD	White Corrosion Resistant
DBXD	Black Corrosion Resistant

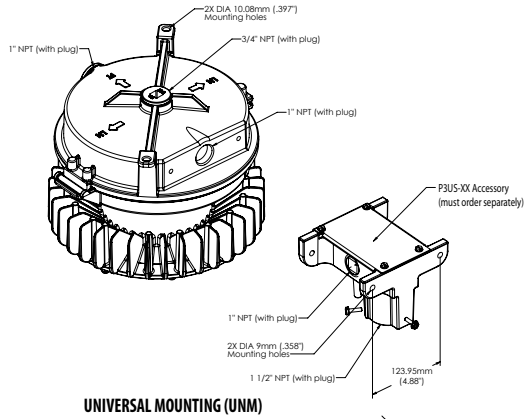
NOTE: ‡ indicates option chosen has ordering restrictions. Please reference ordering restrictions chart.

For Accessories and Footnotes, see next page.

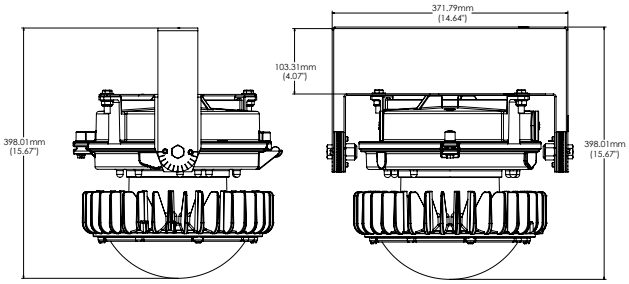
Accessories: *Order as separate catalog number.*	
072331 XX CR	Substation Arm for Single Luminaire, XX denotes color ‡
072331CTL XX CR	Substation Arm for Single Luminaire with controls, XX denotes color ‡
HSCKX	X safety chain kit ‡
MI3502 THREAD SEAL	Thread Sealant
P3US XX CR	Universal Mount Arm, XX denotes color ‡
P3US35 XX CR	35 degree universal mount arm, XX denotes color ‡
PCPXLW XX CR	Pendant Cone, XX denotes color ‡
UPSPXLW XX CR	Uplight shield, XX denotes color ‡
WGPXLW	Wire Guard

‡ Option Value Ordering Restrictions	
Option value	**Restriction**
072331 XX CR, 072331CTL XX CR	Not available with YK90. Fixture to be mounted in down orientation only.
AO	Not available with dimming sensors, Bluetooth sensors or Xpoint wireless.
Bluetooth® Sensors	Not available with HVOLT in the 3000LM or 5000LM lumen packages. BTP sensor options with 3000LM or 5000LM lumen packages cannot dim to OFF. These lumen packages will dim to 10% minimum and cannot be turned OFF with controls. Not available with AO, Xpoint Wireless or BSL310HAZSB in any lumen package.
BP	Not available with MVOLT, HVOLT or 480.
BSL310HAZB	Available with MSI10NWL or MSI10NWL DSCNWL. Not available with HVOLT, 347, 480 or any other controls. Available with CD4K3 or CD4W3, but not required.
CNP164CWL3FT, CNP164CWWL3FT	Available with BSL310HAZB battery only.
Cords (No Plug)	Available with YK90 only.
Finish	Corrosion Resistant Paint is standard.
HSCKX	X denotes length. Available in multiple sizes. Replace X with size in inches. Example: HSCK120 = 120 inches or 10 feet.
NSG	Not available with SO or SOND. Available with Class 1 Division 2 listing only.
P3US35 XX CR, P3US XX CR	Available with UNM mounting option only.
PCPXLW XX CR	Available with PM mounting option only.
Dimming Sensors	Not available with AO.
UPS, UPSPXLW XX CR	When paired with any sensor option, the sensor viewing angle will be cutoff.
XPoint™ Wireless	Not available with HVOLT, AO or BSL310HAZSB

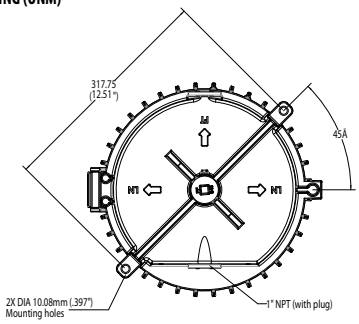
DIMENSIONAL DATA



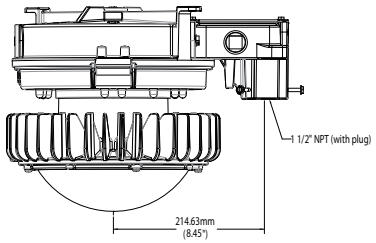
UNIVERSAL MOUNTING (UNM)



YOKE MOUNT 0-90 DEGREE (YK90)

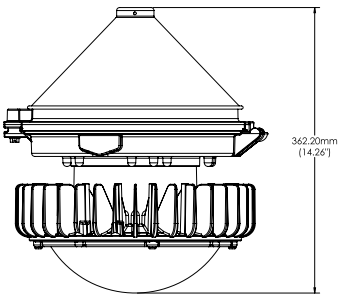


UNIVERSAL MOUNTING (UNM)

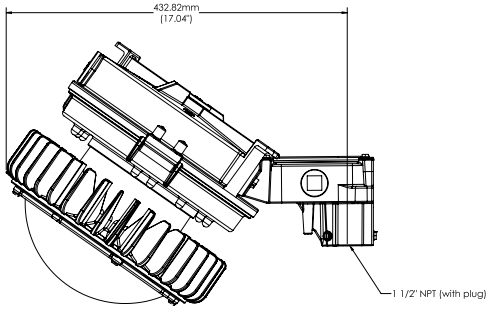


UNIVERSAL MOUNTING (UNM) with P3US Accessory
(must order separately)

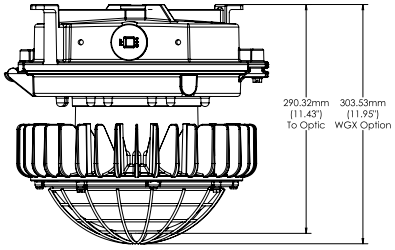
DIMENSIONAL DATA (continued)



PENDANT CONE ACCESSORY



UNIVERSAL MOUNTING (UNM) with P3US35 Accessory (must order separately)



WIRE GUARD OPTION (WGX)

OPERATIONAL DATA

Performance with AO Field Adjustable Output

FAO Setting	Base Max Lumen Output %
1	35%
2	48%
3	61%
4	74%
5	87%
6	100%
7	100%
8	100%

Impact Resistance (IK Ratings)

Lens Material	Rating
Glass	IK07
Silicone	IK10

Projected Lumen Maintenance (TM-21)

25C ambient						
Lumen Package	0 Hours	15,000 Hours	30,000 Hours	45,000 Hours	60,000 Hours	100,000 Hours
3,000LM	1	0.97	0.95	0.92	0.9	0.84
5,000LM	1	0.97	0.95	0.92	0.9	0.84
8,000LM	1	0.97	0.94	0.92	0.89	0.83
10,000LM	1	0.97	0.95	0.92	0.9	0.84

55C ambient						
Lumen Package	0 Hours	15,000 Hours	30,000 Hours	45,000 Hours	60,000 Hours	100,000 Hours
3,000LM	1	0.97	0.94	0.91	0.88	0.81
5,000LM	1	0.97	0.94	0.91	0.89	0.82
8,000LM	1	0.96	0.93	0.89	0.86	0.78
10,000LM	1	0.96	0.93	0.9	0.87	0.79

Default Bluetooth Sensor Programming

Model	Default Operation	Occupancy Time Delay	Photocell Mode	Photocell Set-point	Low Trim	High Trim	Dim to Off Time Delay
SBG10 OCC BTP	On/Off Occupancy Only Disabled	10 minutes	Disabled	n/a	n/a	100%	Disabled
SBG10 HL BTP	Occupancy w/ 0-10V Dimming (High/Low/Off)	10 minutes	Disabled	n/a	10%	100%	2.5 minutes
SBG10 ADC BTP	Occupancy w/ Dim & Switch Photocell	10 minutes	On/Off & Auto Dim	50 fc	10%	100%	0 seconds
SBG10 ANL BTP	Dim & Switch Photocell with High/Low Occupancy Operation	10 minutes	On/Off & Auto Dim	50 fc	10%	100%	Stay Dim/Never Off

Operating Characteristics

Package	Distribution	Delivered lumens at 3000K CCT 70CRI @ 25C	Delivered lumens at 3000K CCT 80CRI @ 25C	Delivered lumens at 3000K CCT 90CRI @ 25C	Delivered lumens at 4000K CCT 70CRI @ 25C	Delivered lumens at 4000K CCT 80CRI @ 25C	Delivered lumens at 4000K CCT 90CRI @ 25C	Delivered lumens at 5000K CCT 70CRI@ 25C	Delivered lumens at 5000K CCT 80CRI@ 25C	Delivered lumens at 5000K CCT 90CRI @ 25C	Wattage	LPW @ 4000K 80CRI
3000LM	FWD	2848	2621	2167	2988	2712	2184	3110	2746	2202	21	127
	MD0	3035	2793	2308	3183	2785	2327	3314	2821	2346	21	130
	MDU5	2700	2485	2054	2833	2803	2071	2949	2839	2087	21	131
	MDU5FR	3021	2780	2298	3169	2883	2316	3299	2920	2335	21	135
	LND	2698	2483	2053	2831	2596	2069	2947	2630	2086	21	121
	SO	3182	2928	2421	3338	2934	2440	3475	2971	2460	21	137
	WD	3098	2851	2357	3250	2850	2376	3383	2887	2395	21	133
5000LM	FWD	4852	4465	3691	5090	4619	3721	5298	4679	3750	35	130
	MD0	5169	4757	3933	5423	4745	3964	5645	4805	3996	35	134
	MDU5	4600	4233	3499	4826	4776	3528	5023	4837	3556	35	135
	MDU5FR	5146	4735	3915	5398	4911	3946	5619	4974	3978	35	139
	LND	4597	4230	3497	4822	4423	3525	5020	4480	3553	35	125
	SO	5421	4989	4124	5687	4998	4157	5920	5062	4191	35	141
	WD	5278	4857	4015	5537	4856	4048	5764	4918	4080	35	137
8000LM	FWD	7751	7133	5896	8131	7380	5944	8464	7474	5991	58	128
	MD0	8258	7600	6282	8664	7580	6333	9018	7677	6384	58	132
	MDU5	7349	6763	5590	7709	7629	5636	8025	7727	5681	58	132
	MDU5FR	8221	7565	6254	8624	7846	6304	8977	7947	6355	58	136
	LND	7344	6758	5586	7704	7066	5632	8019	7156	5677	58	123
	SO	8660	7970	6588	9085	7984	6641	9457	8086	6694	58	139
	WD	8432	7759	6414	8846	7757	6466	9208	7857	6518	58	135
10000LM	FWD	9796	9015	7452	10277	9327	7512	10698	9447	7573	74	126
	MD0	10438	9605	7940	10950	9580	8004	11398	9703	8068	74	129
	MDU5	9288	8547	7066	9744	9643	7123	10143	9766	7180	74	130
	MDU5FR	10390	9561	7904	10900	9916	7968	11346	10044	8032	74	134
	LND	9281	8541	7061	9737	8930	7118	10136	9045	7175	74	121
	SO	10946	10073	8327	11483	10091	8394	11953	10220	8461	74	136
	WD	10657	9807	8107	11180	9804	8173	11638	9930	8238	74	132

Ambient Temperature Ratings

Mounting	OCC Sensor	Xpoint	BTP Sensor	Battery	Voltage	Ambient				Supply Wire
				BSL310HAZSB		3000LM	5000LM	8000LM	10000LM	
PM, UNM, YK90	N	N	N	N	Any	65		60	55	90C
				Y	120-277	40		35		
			Y	N	Any	60		60	55	
				Y	120-277	-				
		Y	N	N	Any	65		60	55	
				Y	120-277	-				
			Y	N	Any	-				
				Y	120-277	-				
	Y	N	N	N	Any	65		60	55	
				Y	120-277	40		35		
			Y	N	Any	-				
				Y	120-277	-				
		Y	N	N	Any	-				
				Y	120-277	-				
			Y	N	Any	-				
				Y	120-277	-				

Glass Lens (MD0, MDU5, MDU5GLF, WD, ND, FWD)

40C° Ambient			
Lumen Package	C1D2	C2D1/C2D2/C3	Simultaneous C1 and C2
3000LM	T4	T6	T3
5000LM	T4	T6	T2C
8000LM	T4	T6	T3
10000LM MVOLT	T2C	T6	T3
10000LM HVOLT	T2	T4	T2C

60C° Ambient			
Lumen Package	C1D2	C2D1/C2D2/C3	Simultaneous C1 and C2
3000LM	T4	T6	T2C
5000LM	T3A	T6	T2C
8000LM	T4	T6	T2C
10000LM MVOLT	N/A	N/A	N/A
10000LM HVOLT	N/A	N/A	N/A

55C° Ambient			
Lumen Package	C1D2	C2D1/C2D2/C3	Simultaneous C1 and C2
3000LM	T3C	T6	T2D
5000LM	T3	T6	T2D
8000LM	T3C	T6	T2D
10000LM MVOLT	T3	T6	T2D
10000LM HVOLT	T2A	T3C	T2

65C° Ambient			
Lumen Package	C1D2	C2D1/C2D2/C3	Simultaneous C1 and C2
3000LM	T3C	T6	T2C
5000LM	T3A	T6	T2C
8000LM	N/A	N/A	N/A
10000LM MVOLT	N/A	N/A	N/A
10000LM HVOLT	N/A	N/A	N/A

Silicone Lens (SO, SOND)

40C° Ambient			
Lumen Package	C1D2	C2D2/C3	Simultaneous C1 and C2
3000LM	T4	T6	T2A
5000LM	T4	T6	T2A
8000LM	T4	T6	T2A
10000LM MVOLT	T2C	T6	T2A
10000LM HVOLT	T2	T6	T2A

60C° Ambient			
Lumen Package	C1D2	C2D2/C3	Simultaneous C1 and C2
3000LM	T4	T5	T2
5000LM	T3A	T5	T2
8000LM	T4	T5	T2
10000LM MVOLT	N/A	N/A	N/A
10000LM HVOLT	N/A	N/A	N/A

55C° Ambient			
Lumen Package	C1D2	C2D2/C3	Simultaneous C1 and C2
3000LM	T3C	T5	T2
5000LM	T3	T5	T2
8000LM	T3C	T5	T2
10000LM MVOLT	T3	T5	T2
10000LM HVOLT	T2A	T5	T2

65C° Ambient			
Lumen Package	C1D2	C2D2/C3	Simultaneous C1 and C2
3000LM	T3C	T4A	T1
5000LM	T3A	T4A	T1
8000LM	N/A	N/A	N/A
10000LM MVOLT	N/A	N/A	N/A
10000LM HVOLT	N/A	N/A	N/A

Hazardous Compatibility			
Options	C1D2	C2D1	C2D2/C3
FWD, MD0, MDU5, MDU5FR, LND, WD	YES	YES	YES
SO, SOLND	YES	NO	YES
PM	YES	YES	YES
UNM	YES	YES	YES
YK90	YES	YES	YES
AO	NO	YES	YES
BP	YES	NO	YES
BSL310HAZB	YES	YES	YES
CNP16WWL3FT, CNP164CWL3FT, CNP164CWWL3FT, CNP165CDWL3FT, CNP165CDWWL3FT	YES	YES	YES
SBG10 OCC BTP, SBG10 HL BTP, SBG10 ADC BTP, SBG10 ANL BTP	YES	NO	YES
SBGR10, SBGR10 D 3V, SBGR10 P, XPADS SBG10	NO	NO	YES
XAD, XAD924	NO	YES	YES

Accessories	C1D2	C2D1	C2D2/C3
072331, 072331CTL	YES	NO	YES
P3US	YES	YES	YES
P3US35	YES	YES	YES
UPS (uplight shield)	YES	YES	YES
PC (pendant cone)	YES	YES	YES
WG (wireguard)	YES	YES	YES

Marine/NEMA4X Compatibility Chart			
Options		Marine	NEMA4X
Lumen Packages	3000LM	YES	YES
	5000LM	YES	YES
	8000LM	YES	YES
	10000LM	YES	YES
Optics	MD0	YES	YES
	MDU5	YES	YES
	MDU5FR	YES	YES
	WD	YES	YES
	LND	YES	YES
	FWD	YES	YES
	SO	NO	NO
	SOLND	NO	NO
Voltage	MVOLT	YES	YES
	120	YES	YES
	208	YES	YES
	240	YES	YES
	277	YES	YES
	HVOLT	YES	YES
	347	YES	YES
	480	YES	YES
Color Temperature	30K	YES	YES
	40K	YES	YES
	50K	YES	YES
CRI	70CRI	YES	YES
	80CRI	YES	YES
	90CRI	YES	YES
Mounting Options	UNM	YES	YES
	PM	YES	YES
	YK90	NO	YES
Options	AO	YES	YES
	BSL310HAZB	NO	NO
	EMD	YES	YES
	UPS	YES	YES
	USPOM	YES	YES
	WGX	YES	YES
	Any Cordset	NO	NO
Controls	SBG10 OCC BTP	NO	NO
	SBGR10 HL BTP	NO	NO
	SBGR10 ADC BTP	NO	NO
	SBGR10 ANL BTP	NO	NO
	SBGR10	NO	NO
	SBGR10 D 3V	NO	NO
	SBGR10 P	NO	NO
	XPADS SBG10	NO	NO
	XAD	YES	YES
	XAD924	YES	YES
	BP	NO	NO
Fixture Finish	DGXD	YES	YES
	DWHXD	YES	NO
	DBXD	NO	NO
Accessories	72331	YES	NO
	072331-CTL	YES	NO
	PCPXLW	NO	NO
	P3US	NO	NO
	P3US35	NO	NO
	WGPXLW	YES	YES
	UPSPXLW	YES	YES

HALO

DESCRIPTION

High efficacy low profile track fixture ideal for accent and display lighting applications. Featuring die cast construction with a simple low profile design. These lampholders are perfect for those applications where performance is required from a discreet source.

Catalog #		Type L16
Project		
Comments		Date
Prepared by		

SPECIFICATION FEATURES

Quick Lock Adapter*
Attaches electrically and mechanically anywhere along the track. Includes discrete locking tab that locks the luminaire on the track and allows for easy removal and repositioning.

Heat Sink
Aluminum die-cast heat sink provides exceptional thermal management to yield 70% lumen maintenance after 50,000 hours of operation.

LED Light Engine
Chip on board LED provides a uniform source with high efficiency and no pixilation. Available in 90 CRI minimum, R9 greater than 50 and color accuracy within 3 SDCM provide color accuracy and uniformity.

Optics
Configurable optics allow for the reflectors to be changed in the field to adjust to the current lighting need. Available in spot, flood and narrow flood distributions.

Media
Precision designed trim ring contains unique teeth locking mechanism, and can accept up to 2 pieces of standard media. The 3" diameter fixture accepts PAR 20 standard media. The 4" diameter fixture accepts PAR 30 standard media.

Luminaire Arm
Arm allows the lamp housing tilt to adjust ±180° vertically and ±350° horizontally. This enables a clean look while providing full aiming capabilities.

Dimming
TRIAC, ELV or Phasecut

- Designed for continuous dimming capability to nominally 5% with many 120V Leading Edge (LE) and Trailing Edge (TE) Phase Control Dimmers. (Dimmers with low end trim adjustment offer greater assurance of achieving 5% level.)
- Consult dimmer manufacturer for compatibility and conditions of use.
- Dimming only available with 120V configurations.

Warranty
Five year limited warranty, consult website for details.
www.cooperlighting.com

Drivers
3" fixtures (12W and 21W) contain integral 120V, 50/60 Hz constant current driver that provides noise free operation. 4" fixtures (35W) contain 120V 50/60Hz constant current driver that provides noise free operation.

Compliance
cULus listed / certified for use with Halo Single Circuit Power-Trac and Global® TEK/HTEK track (See Footnote #1 below Ordering Information). NSF non-food zone compliant. EMI/RFI emissions per FCC 47CFR Part 15 Class B consumer limits. Contains no mercury or lead and RoHS compliant. Photometric testing in accordance with IES LM-79-08. Lumen maintenance projections in accordance with IES LM-80-08 and TM-21-11.

NSF/ANSI 2

L808

LED Track Head
3-Inch and 4-Inch
Flat Back Cylinder

90 CRI

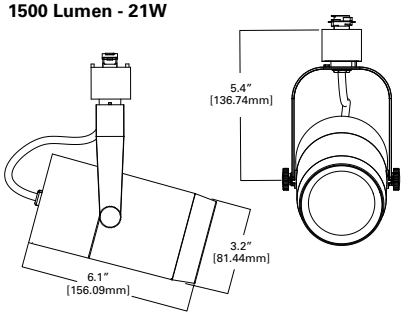
850lm package - 12W	CBCP
Spot 14°	8,544
Narrow Flood 21°	5,207
Flood 41°	1,610
Lighting Data - 3000K Spot	
Lumens	1007
Lumens per watt:	84.6
Energy Data	
Input Power:	11.89W
Power Factor:	≥.99
Input Current:	.113A

1500lm package - 21W	CBCP
Spot 14°	11,474
Narrow Flood 21°	7,778
Flood 41°	2,864
Lighting Data - 3000K Spot	
Lumens	1506
Lumens per watt:	72.7
Energy Data	
Input Power:	20.66W
Power Factor:	≥.99
Input Current:	.174A

2500lm package - 35W	CBCP
Spot 12°	29,149
Narrow Flood 24°	9,865
Flood 33°	6,485
Lighting Data - 3000K Spot	
Lumens	2404
Lumens per watt:	68.9
Energy Data	
Input Power:	34.86W
Power Factor:	≥.99
Input Current:	.29A

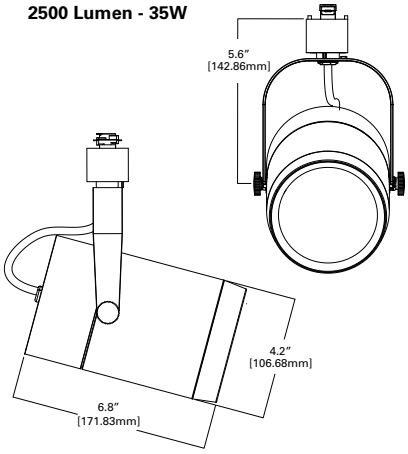
3-Inch Fixture**

850 Lumen - 12W
1500 Lumen - 21W



4-Inch Fixture**

2500 Lumen - 35W



COOPER Lighting Solutions

Cooper Lighting Solutions
1121 Highway 74 South
Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

Specifications and dimensions subject to change without notice.

***Note:** Fixture to only be attached to horizontally installed track systems.
****Note:** The above drawing represents the 808 track with Halo Adapter. Other adapter options may be different in size and apperance.

TD518038EN
5/03/2020

L16

ORDERING INFORMATION

SAMPLE NUMBER: L80815SP9030AH (Halo Track connector, 1500 lumen, Spot Distribution, 90 CRI, 3000K, with Aluminum Haze Finish)

Track	LED	Series	Lumen Package	Distribution	CRI	CCT	Finish	Voltage
L=Halo Single Circuit Power Trac ~~**LJ**=Juno® Track[1]~~ **LL**=Lightolier® Track[2] **L2G**=Global® TEK or HTEK[3] **LZ**=Lazer and Halo two circuit Power Trac (round adapter)	**8**=LED	**08**=Cylinder	~~**08**=850 lm~~ **15**=1500 lm ~~**25**=2500 lm~~	**SP**=Spot **NF**=Narrow Flood **FL**=Flood	**90**=90	**27**=2700K ~~**30**=3000K~~ **35**=3500K ~~**40**=4000K~~	**AH**=Aluminum Haze **MB**=Black **P**=White	**Blank**=120V ~~**277**=277V[1]~~

Accessories (order separately)

Reflectors
SREF-808302-PK= Spot Reflector 3"
FREF-808302-PK=Flood Reflector 3"
NFREF-808302-PK=Narrow Flood Reflector 3"
SREF-808402-PK= Spot Reflector 4"
FREF-808402-PK=Flood Reflector 4"
NFREF-808402-PK=Narrow Flood Reflector 4"

Media - 3"
Color Filters
F22-20=Red
F33-20=Blue
F44-20=Green
F55-20=Yellow
F66-20=Mercury

Dichronic Filters
F71-20=Peach
F72-20=Amber
F73-20=Green
F74-20=Medium Blue
F75-20=Yellow
F76-20=Red
F77-20=Dark Blue
F78-20=Light Blue
F79-20=Neutral Density
F80-20=Magenta

Beam-Modifying Lenses
DIF-20=Diffused Lens
~~**OSL-20**=Overall Spread Lens~~
LSL-20=Linear Spread Lens

Louvers
LVR-20=Hex Cell Louver

Media - 4"
Color Filters
LND-RED=Red Color Filter
LND-BLU=Blue Color Filter

Dichronic Filters
LND-CLR=Clear Protective Glass Lens
LND-AMB=Amber Color Filter
LND-PCH=Cosmetic Peach Filter
LND-MWL=Milk White Lens

Beam-Modifying Lenses
LND-UVF=Optivex™ UN Filter
LND-DSL=Diffusion Spread Lens
LND-LSL=Linear Spread Lens
LND-PSL=Prismatic Spread Lens

Louvers
LND-LVR=Hex Cell Louver

NOTES: 1. Juno® T single circuit and 2-circuit track contact. Juno® is a registered trademark of Juno® Lighting. **2.** Lightolier® Lyfespan 6000 single circuit and 2 circuit track contact. Lightolier® is a registered trademark of Philips Lighting. **3.** Global® is a registered trademark of Nordic Aluminum. **4.** Only available with L2G adapter for Global HTEK track.

Select models are DesignLights™ Consortium Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.

Summary based 90 CRI 3000K White finish. Full data available in IES files online.

PHOTOMETRICS

12W

Color Temp = 3000K
4000K Multiplier = 1.25

Spot: 14°
CBCP: 8544
Lumens: 1007
LpW: 84.6

0 deg Aiming Angle Horizontal Footcandles				30 deg Aiming Angle Horizontal Footcandles					30 deg Aiming Angle Vertical Footcandles on Wall					60 deg Aiming Angle Vertical Footcandles on Wall				
MH	FC	L	W	MH	FC	L	W	CB	D	FC	L	W	CB	D	FC	L	W	CB
5'	341.9	1.2	1.2	5'	225.5	1.5	1.2	2.9	3'	136	2.5	1.2	5.2	3'	626.3	0.8	0.8	1.7
7.5'	152	1.8	1.8	7.5'	100.2	2.3	2	4.3	4'	76.5	3.5	1.8	6.9	4'	352.3	1.1	1	2.3
10'	85.5	2.4	2.4	10'	56.4	3.1	2.6	5.8	5'	49	4.3	2.2	8.7	5'	225.5	1.5	1.2	2.9
12.5'	54.7	3	3	12.5'	36.1	3.9	3.4	7.2	6'	34	5.2	2.6	10.4	6'	156.6	1.8	1.6	3.5
15'	38	3.6	3.6	15'	25.1	4.7	4	8.7										

Narrow Flood: 21°
CBCP: 5207
Lumens: 994
LpW: 83.5

MH	FC	L	W	MH	FC	L	W	CB	D	FC	L	W	CB	D	FC	L	W	CB
5'	208.3	1.8	1.8	5'	140.5	2.3	2	2.9	3'	97.2	3.2	1.8	5.2	3'	390.4	1.3	1.2	1.7
7.5'	92.6	2.6	2.6	7.5'	62.5	3.4	3	4.3	4'	54.7	4.3	2.4	6.9	4'	219.6	1.8	1.6	2.3
10'	52.1	3.6	3.6	10'	35.1	4.6	4	5.8	5'	35	5.4	3	8.7	5'	140.5	2.3	2	2.9
12.5'	33.3	4.4	4.4	12.5'	22.5	5.7	5	7.2	6'	24.3	6.5	3.6	10.4	6'	97.6	2.6	2.4	3.5
15'	23.1	5.4	5.4	15'	15.6	6.9	6	8.7										

Flood: 41°
CBCP: 1610
Lumens: 945
LpW: 79.4

MH	FC	L	W	MH	FC	L	W	CB	D	FC	L	W	CB	D	FC	L	W	CB
5'	77.4	3.4	3.4	5'	58.8	3.6	3.6	2.9	3'	58.6	2.8	2.8	5.2	3'	163.3	2.1	2.2	1.7
7.5'	34.4	5.2	5.2	7.5'	26.1	5.4	5.6	4.3	4'	32.9	3.8	3.8	6.9	4'	91.9	2.8	2.8	2.3
10'	19.4	7	7	10'	14.7	7.3	7.4	5.8	5'	21.1	4.8	4.6	8.7	5'	58.8	3.6	3.6	2.9
12.5'	12.4	8.6	8.6	12.5'	9.4	9.1	9.2	7.2	6'	14.6	5.7	5.6	10.4	6'	40.8	4.3	4.4	3.5
15'	8.6	10.4	10.4	15'	6.5	10.9	11.2	8.7										

PHOTOMETRICS

L16

21W

Color Temp = 3000K
4000K Multiplier = 1.25

0 deg Aiming Angle Horizontal Footcandles

	MH	FC	L	W
Spot: 14°	5'	511.3	1.2	1.2
CBCP: 11474	7.5'	227.3	1.8	1.8
Lumens: 1506	10'	127.8	2.4	2.4
LpW: 72.7	12.5'	81.8	3	3
	15'	56.8	3.6	3.6
Narrow Flood: 21°	5'	317	1.8	1.8
CBCP: 7778	7.5'	140.9	2.6	2.6
Lumens: 1512	10'	79.2	3.6	3.6
LpW: 73	12.5'	50.7	4.4	4.4
	15'	35.2	5.4	5.4
Flood: 41°	5'	117.8	3.4	3.4
CBCP: 2864	7.5'	52.4	5.2	5.2
Lumens: 1439	10'	29.5	7	7
LpW: 6935	12.5'	18.8	8.6	8.6
	15'	13.1	10.4	10.4

30 deg Aiming Angle Horizontal Footcandles

	MH	FC	L	W	CB
Spot: 14°	5'	337.2	1.5	1.2	2.9
CBCP: 11474	7.5'	149.9	2.3	2	4.3
Lumens: 1506	10'	84.3	3.1	2.6	5.8
LpW: 72.7	12.5'	54	3.9	3.4	7.2
	15'	37.5	4.7	4	8.7
Narrow Flood: 21°	5'	213.9	2.3	2	2.9
CBCP: 7778	7.5'	95.1	3.4	3	4.3
Lumens: 1512	10'	53.5	4.6	4	5.8
LpW: 73	12.5'	34.2	5.7	5	7.2
	15'	23.8	6.9	6	8.7
Flood: 41°	5'	89.5	3.6	3.6	2.9
CBCP: 2864	7.5'	39.8	5.4	5.6	4.3
Lumens: 1439	10'	22.4	7.3	7.4	5.8
LpW: 6935	12.5'	14.3	9.1	9.2	7.2
	15'	9.9	10.9	11.2	8.7

30 deg Aiming Angle Vertical Footcandles on Wall

	D	FC	L	W	CB
Spot: 14°	3'	203.5	2.5	1.2	5.2
CBCP: 11474	4'	114.5	3.5	1.8	6.9
Lumens: 1506	5'	73.2	4.3	2.2	8.7
LpW: 72.7	6'	50.9	5.2	2.6	10.4
Narrow Flood: 21°	3'	148	3.2	1.8	5.2
CBCP: 7778	4'	83.3	4.3	2.4	6.9
Lumens: 1512	5'	53.3	5.4	3	8.7
LpW: 73	6'	37	6.5	3.6	10.4
Flood: 41°	3'	89.1	2.8	2.8	5.2
CBCP: 2864	4'	50.1	3.8	3.8	6.9
Lumens: 1439	5'	32.1	4.8	4.6	8.7
LpW: 6935	6'	22.3	5.7	5.6	10.4

60 deg Aiming Angle Vertical Footcandles on Wall

	D	FC	L	W	CB
Spot: 14°	3'	936.8	0.8	0.8	1.7
CBCP: 11474	4'	526.9	1.1	1	2.3
Lumens: 1506	5'	337.2	1.5	1.2	2.9
LpW: 72.7	6'	234.2	1.8	1.6	3.5
Narrow Flood: 21°	3'	594.1	1.3	1.2	1.7
CBCP: 7778	4'	334.2	1.8	1.6	2.3
Lumens: 1512	5'	213.9	2.3	2	2.9
LpW: 73	6'	148.5	2.6	2.4	3.5
Flood: 41°	3'	248.6	2.1	2.2	1.7
CBCP: 2864	4'	139.8	2.8	2.8	2.3
Lumens: 1439	5'	89.5	3.6	3.6	2.9
LpW: 6935	6'	62.1	4.3	4.4	3.5

35W

Color Temp = 3000K
4000K Multiplier = 1.25

0 deg Aiming Angle Horizontal Footcandles

	MH	FC	L	W
Spot: 12°	5'	1170.1	1	1
CBCP: 29149	7.5'	520	1.4	1.4
Lumens: 2404	10'	292.5	2	2
LpW: 68.9	12.5'	187.2	2.4	2.4
	15'	130	3	3
Narrow Flood: 24°	5'	397.1	2	2
CBCP: 9865	7.5'	176.5	3	3
Lumens: 2272	10'	99.3	4	4
LpW: 65.1	12.5'	63.5	5	5
	15'	44.1	6	6
Flood: 33°	5'	261.2	2.6	2.6
CBCP: 6485	7.5'	116.1	4	4
Lumens: 2293	10'	65.3	5.2	5.2
LpW: 65.7	12.5'	41.8	6.6	6.6
	15'	29	8	8

30 deg Aiming Angle Horizontal Footcandles

	MH	FC	L	W	CB
Spot: 12°	5'	767.4	1.3	1	2.9
CBCP: 29149	7.5'	341.1	1.9	1.6	4.3
Lumens: 2404	10'	191.9	2.6	2.2	5.8
LpW: 68.9	12.5'	122.8	3.2	2.8	7.2
	15'	85.3	3.9	3.4	8.7
Narrow Flood: 24°	5'	274.9	2.5	2.2	2.9
CBCP: 9865	7.5'	122.2	3.8	3.2	4.3
Lumens: 2272	10'	68.7	5.1	4.4	5.8
LpW: 65.1	12.5'	44	6.4	5.6	7.2
	15'	30.5	7.7	6.6	8.7
Flood: 33°	5'	185.6	3.2	2.8	2.9
CBCP: 6485	7.5'	82.5	4.9	4.4	4.3
Lumens: 2293	10'	46.4	6.5	5.8	5.8
LpW: 65.7	12.5'	29.7	8.2	7.2	7.2
	15'	20.6	9.9	8.8	8.7

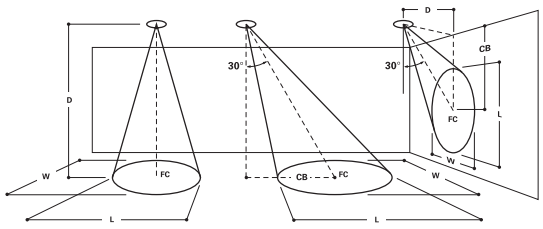
30 deg Aiming Angle Vertical Footcandles on Wall

	D	FC	L	W	CB
Spot: 12°	3'	449.5	2.1	1	5.2
CBCP: 29149	4'	252.8	2.8	1.4	6.9
Lumens: 2404	5'	161.8	3.5	1.8	8.7
LpW: 68.9	6'	112.4	4.3	2.2	10.4
Narrow Flood: 24°	3'	199.7	3.3	2	5.2
CBCP: 9865	4'	112.4	4.5	2.6	6.9
Lumens: 2272	5'	71.9	5.7	3.2	8.7
LpW: 65.1	6'	49.9	6.8	4	10.4
Flood: 33°	3'	150.8	3.4	2.4	5.2
CBCP: 6485	4'	84.8	4.5	3.4	6.9
Lumens: 2293	5'	54.3	5.6	4.2	8.7
LpW: 65.7	6'	37.7	6.8	5	10.4

60 deg Aiming Angle Vertical Footcandles on Wall

	D	FC	L	W	CB
Spot: 12°	3'	2131.7	0.7	0.6	1.7
CBCP: 29149	4'	1199.1	1	0.8	2.3
Lumens: 2404	5'	767.4	1.3	1	2.9
LpW: 68.9	6'	532.9	1.5	1.2	3.5
Narrow Flood: 24°	3'	763.5	1.4	1.2	1.7
CBCP: 9865	4'	429.5	2	1.8	2.3
Lumens: 2272	5'	274.9	2.5	2.2	2.9
LpW: 65.1	6'	190.9	3	2.6	3.5
Flood: 33°	3'	515.5	1.9	1.6	1.7
CBCP: 6485	4'	290	2.6	2.2	2.3
Lumens: 2293	5'	185.6	3.2	2.8	2.9
LpW: 65.7	6'	128.9	3.9	3.4	3.5

Notes and Definitions:
Beam spread is to 50% center beam candlepower (CBCP.)
D=Distance in feet to floor or wall.
FC=Footcandles on floor or wall at center beam aiming location.
L =Effective Visual Beam length in feet (50% of maximum footcandle level.)
W=Effective Visual Beam width in feet (50% of maximum footcandle level.)
CB=Distance in feet across or down to center beam location.



COOPER Lighting Solutions

Cooper Lighting Solutions
1121 Highway 74 South
Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

HALO

DESCRIPTION

Miniature size, decorator finishes, push-in connectors, economy, all combine to make single-circuit Miniature Trac perfect for residential or commercial use. Polarized connectors and end caps are molded polycarbonate. Halo Miniature Track accepts both Halo and Lazer-by-Halo lampholders.

Catalog #		Type
Project		L16A
Comments		Date
Prepared by		

SPECIFICATION FEATURES

A. Structural
- Extruded aluminum .060" [1.5mm] nominal wall thickness

B. Line Conductor
- Solid copper bus bars [cross section equivalent to #12 AWG wire].

C. Insulating Liner
- Extruded polyvinyl insulator.

D. Ground Conductor
- Exclusive independent grounding bus conductor. Maintains an independent positive ground #12 AWG path between lampholder, Trac channel and building's ground system.

E. Neutral Conductor
- Cross section equivalent of #12 AWG wire.

F. Polarity Indicator (Neutral)
- Visual polarity groove indicates proper electrical installation of lampholder adapter.

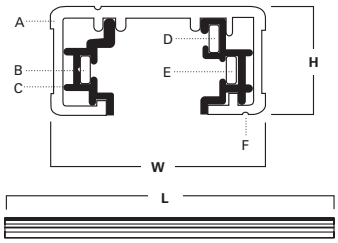
Listings
- cULus listed for use with Halo and Lazer-by-Halo lampholders.

Mounting
- Track system is recommended for ceiling mount only. For alternate mounting methods consult factory.

L650, L651
L652, L653

MINIATURE SINGLE CIRCUIT TRAC SYSTEM

Power -Trac



	L	W	H
L650 2' Nominal	20-1/8" [511mm]	1-3/8" [35mm]	11/16" [18mm]
L651 4' Nominal	44-1/8" [1121mm]	1-3/8" [35mm]	11/16" [18mm]
L652 8' Nominal	92-1/8" [2340mm]	1-3/8" [35mm]	11/16" [18mm]
L653 12' Nominal	140-1/8" [3559mm]	1-3/8" [35mm]	11/16" [18mm]

ORDERING INFORMATION

SAMPLE NUMBER: L651MB

Track	Finishes	Connectors (Order Separately)	Accessories (Order Separately)	Current Limiters (Order Separately)
L650= 2' **L651**= 4' **L652**= 8' **L653**= 12'	**P**=White **MB**=Black	**L900**=Outlet Box Cover **L901**=Live End Connector **L902**=Flexible Connector **L903**=Straight Connector **L904**=L Connector **L905**=T Connector **L906**=X Connector **L907**=Outlet Box for use with T-Bar ceiling **L908**=Mini Joiner **L909**=Floating Canopy and Connector **L950**=Cord and Plug Connector **L979**=Conduit Continuation Kit **L980**=Live End Conduit Adapter **DE600**=Dead End Finishes **P**=White **MB**=Black	**L951**=Wire Way Cover for Pendant Assembly Kit **L983**=T-Bar Attachment Clip **L992**=Pendant Kit Assembly **L48**=48" Steel Stem **L994**=Pendant Adapter Finishes **P**=White **MB**=Black	Current Limiter - End Feed **LC901CB120**=120W (1A @ 120V) **LC901CB300**=300W (2.5A @ 120V) **LC901CB600**=600W (5A @ 120V) **LC901CB960**=960W (8A @ 120V) **LC901CB1200**=1200W (10A @ 120V) Current Limiter - Center Feed **LC903CB120**=120W (1A @ 120V) **LC903CB300**=300W (2.5A @ 120V) **LC903CB600**=600W (5A @ 120V) **LC903CB960**=960W (8A @ 120V) **LC903CB1200**=1200W (10A @ 120V) Finishes **P**=White **MB**=Black

As indicated on plan

Provide accessories as required to mount track from structure

COOPER Lighting Solutions

TD518194EN
8/24/2016

L16A

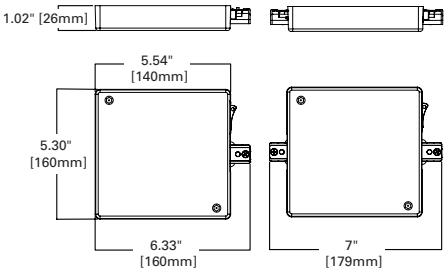
LC901, LC903 Current Limiter - End and Center Feeds

End-feed and Center-feed capable:
Five breaker sizes are available. Consult factory if other sizes are required. Can be utilized on hard or grid ceilings. Can be used with pendant suspended track. Breaker can be used as an on-off switch. Breaker features a "tripped" condition indicator. cULus Listed.

ORDERING INFORMATION

SAMPLE NUMBER: LC901CB120P

Feed Type	Circuit 1 Breaker	Finish
LC901= Halo Power-Trac 1-Circuit End Feed **LC903**= Halo Power-Trac 1-Circuit Center Feed	**CB120**=120W (1A @120V) **CB300**=300W (2.5A @120V) **CB600**=600W (5A @120V) **CB960**=960W (8A @120V) **CB1200**=1200W (10A @120V)	**P**=White **MB**=Black



Sample catalog number: LC901CB120P

Consult factory for Single Circuit Center-feed requiring two circuit breakers.

LC901
LC903

T24 Can be used to comply with California Title 24 High Efficacy requirements
T20 Certified to California Title 20 Appliance Database

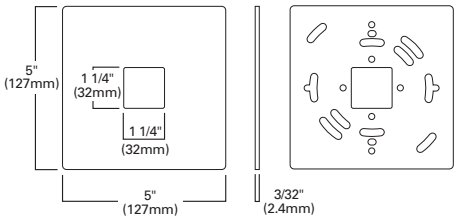
L900 - Outlet Box Cover

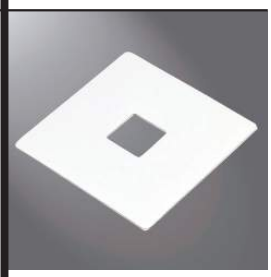
Can be used at any electrical feed connection point (Live, Straight, L,T or X). Drill guides on back for virtually all standard outlet boxes. Size: 5" sq. Screws included.
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L900P

Connector	Finish
L900= Outlet Box Cover	**P**=White **MB**=Black





L900

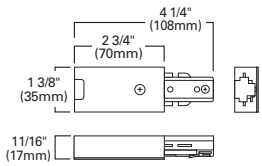
L901 - Live End Connector

To start a run.
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L901P

Connector	Finish
L901= Live End Connector	**P**=White **MB**=Black



L901

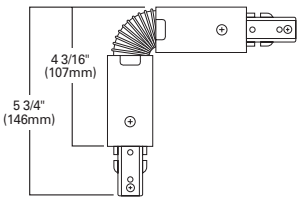
L902 - Flexible Connector

To connect two track sections at any angle up to 90° in either plane or wall to ceiling or pitched ceiling applications.
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L902P

Connector	Finish
L902= Flexible Connector	**P**=White **MB**=Black



L902

L903 - Straight Connector

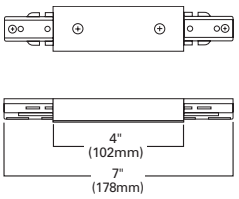
To connect two track sections end-to-end. L903 differs from mini connector L908 in that it provides a center feed option and is longer.May be used as feed point.

Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L903P

Connector	Finish
L903= Straight Connector	**P**=White **MB**=Black



L903

L904 - L Connector

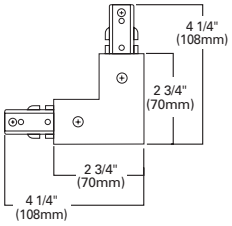
To connect two track sections at a right angle. Field adjustable for either right hand or left hand application. May be used as feed point.

Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L904P

Connector	Finish
L904= L Connector	**P**=White **MB**=Black



L904

L905 - T Connector

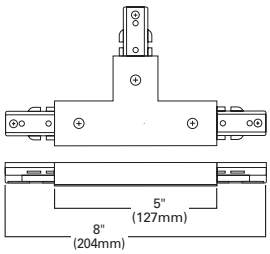
To connect three track sections into a T configuration. Field adjustable for either right hand or left hand application. May be used as feed point.

Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L905P

Connector	Finish
L905= T Connector	**P**=White **MB**=Black



L905

L906 - X Connector

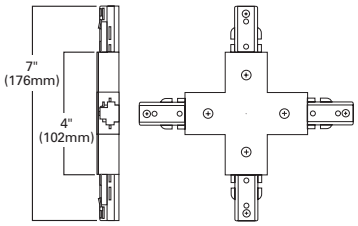
To connect four track sections into a cross configuration. May be used as feed point.

Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L906P

Connector	Finish
L906= X Connector	**P**=White **MB**=Black



L906

L907 - Outlet Box for use with T-Bar Ceiling

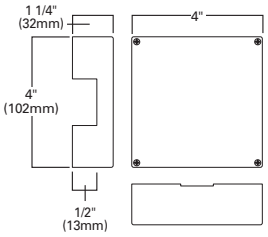
L901, L903, L904, L905 or L906 connector also required. 4″x 4″ x 1 1/8″.

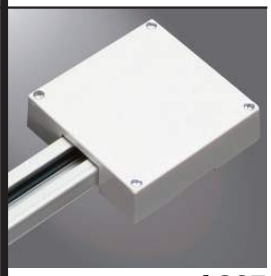
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L907P

Connector	Finish
L907= Outlet Box for use with T-Bar Ceiling	**P**=White **MB**=Black





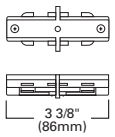
L907

L16A

L908 - Mini Joiner

A low profile connector to cleanly and crisply join two straight track sections end-to-end. (Note: The L908 is not a feed point).

Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L908P

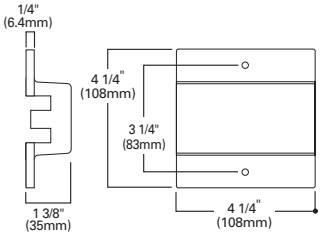
Connector	Finish
L908= Mini Joiner	**P**=White **MB**=Black

L908

L909 - Floating Canopy and Connector

Track can be connected to existing outlet box located anywhere along the track. Comes with canopy cover, connector, dead-end and mounting hardware.
4 1/8" x 4 1/4" x 1 3/8".

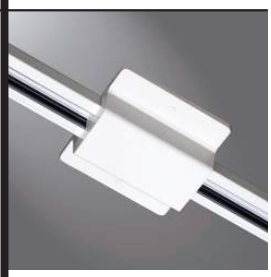
Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L909P

Connector	Finish
L909= Floating Canopy and Connector	**P**=White **MB**=Black

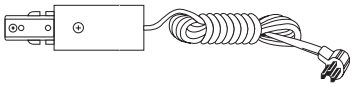


L909

L950 - Cord and Plug Connector

12' three-wire cord with grounded plug. Maximum capacity 10 AMP.

Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L950P

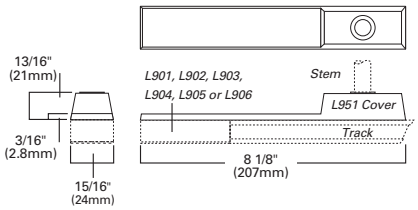
Connector	Finish
L950= Cord and Plub Connector	**P**=White **MB**=Black

L950

L951 - Wire Way Cover for Pendant Assembly Kit

For track to be wired through stem(order one for each feed point used). For use with line connectors (L901, L902, L903, L904, L905 or L906) and pendant stem kit (L992)–order separately.

Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L951P

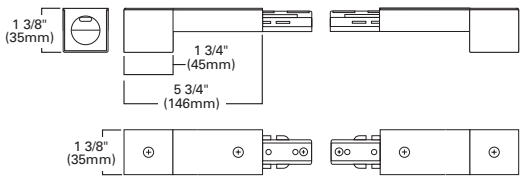
Connector	Finish
L951= Wire Way Cover for Pendant Assembly Kit	**P**=White **MB**=Black

L951

L979 - Conduit Continuation Kit

Consisting of one left feed and one right feed. To continue a run around obstructions. Designed to accept 1/2" trade size conduit fitting (not included).

Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L979P

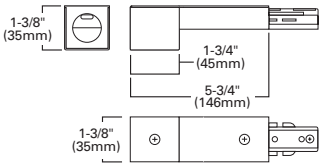
Connector	Finish
L979= Conduit Continuation Kit	**P**=White **MB**=Black

L979

L980 - Live End Conduit Adapter

Designed to accept standard 1/2" trade size conduit fitting (not supplied). Use when feeding to track through surface conduit system.

Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L980P

Connector	Finish
L980= Live End Conduit Adapter	**P**=White **MB**=Black

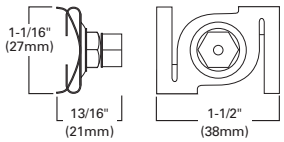
L980

L983 - T-Bar Attachment Clip

Allows track to be attached to inverted tee ceiling. Order as follows: 2 kits for 2' Trac; 2 kits for 4' Trac; 3 kits for 8' Trac and 4 kits for 12' Trac.

L986 Mini-T Bar Clip

For mounting Trac on suspended ceilings with mini-grid (9/16" wide) system.



ORDERING INFORMATION

SAMPLE NUMBER: L983P

Connector	Finish
L983= T-Bar Attachment Clip **L986**= Mini T-Bar Clip	**P**=White **MB**=Black

L983

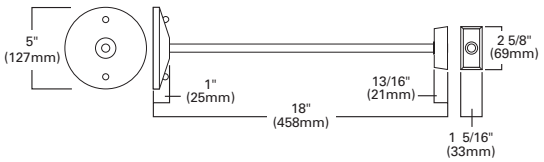
L992 - Pendant Kit Assembly

Order 2 kits for 2' Trac; 2 kits for 4' Trac; 3 kits for 8' Trac; and 4 kits for 12' Trac. Includes one 18" threaded steel stem, canopy andmounting hardware.

L48 48" Steel Stem

For additional length with L992. Can be field cut.

Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L992P

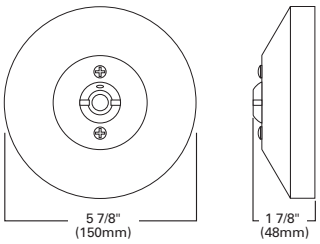
Connector	Finish
L992= Pendant Kit Assembly	**P**=White **MB**=Black

L992

L994 - Pendant Adapter

For installing pendant mounted Power-Trac on sloped ceiling. For use with L992.

Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L994P

Connector	Finish
L994= Pendant Adapter	**P**=White **MB**=Black

L994

DE600 - Dead End

Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: DE600P

Connector	Finish
DE600= Dead End	**P**=White **MB**=Black

DE600

COOPER Lighting Solutions

Cooper Lighting Solutions
1121 Highway 74 South
Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

solid state luminaires

Type:	**Approved:**
Fixture:	
Project:	

CORNERLINE

The **CORNERLINE** is a low profile undercabinet luminaire. **CORNERLINE** comes in a 12 in, 20 in, or 39 in lengths and 2800K or 4000K color temperatures. The housing is constructed of extruded anodized aluminum for interior use only.

L17

SPECIFICATION

color temperature	2800K	4000K
beam spread	90°	
lumen output	260	290
LEDs per foot	CNL-1: 42 CNL-2: 72 CNL-3: 144	
color consistency	3-step MacAdam Ellipse	
lifetime	> 60,000 hours / L70 or better	
input voltage	24V DC	
power consumption	CNL-1: 4W CNL-2: 6W CNL-3: 12W	
dimensions [L x W x H]	A x 1.3 in x 0.7 in	
weight	0.4 lbs	
housing	extruded anodized aluminum	
lens	clear polycarbonate or white, opal polycarbonate	
mounting	surface mount bracket with clips	
operating temperature	-20°C to 40°C	
junction temperature	62°C @ T_A 25°C	
power supply	Class II	
interface	Dimmable 0-10V	
certification	ETL / cETL / CE	
standards	UL-Class II / CE Class III / IES LM-79 / LM-80	
environment	dry, interior location / IP20	
warranty	5 year limited warranty (refer to website for details)	

Due to continuous development and improvements, specifications are subject to change without notice.

CATALOG NUMBER

Refer to length on plan. Coordinate with architectural details.

CNL

model	length	color temperature	options
CNL CORNERLINE	**1** 300mm [12 in]	**28K** 2800K	**WL** White Lens
	2 500mm [20 in]	**4K** 4000K	**PWR-C** Power Button (On fixture)
	3 1000mm [39 in]		

Accessories (Indicate the quantity needed for each item.)

_____ **SC-C** Straight Connector
_____ **MC-C** Mounting Clips
_____ **CC3** Connector Cable (3 ft.)
_____ **CC6** Connector Cable (6 ft.)
_____ **4S** 4-Way Splitter
_____ **8S** 8-Way Splitter
_____ **PD** Portable Dimmer
_____ **PPS** Portable Power Supply (36W)
_____ **EN25** 25W Hard Wire Power Supply
_____ **EN50** 50W Hard Wire Power Supply
_____ **EN100** 100W Hard Wire Power Supply
_____ **DIM** Hard Wire Dimmer (0-10V)
_____ **MD** Motion Detector (0-10V)

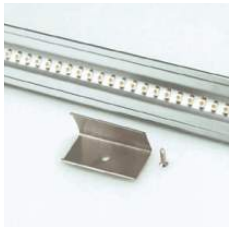
3609 Swenson Ave., St. Charles, IL 60174. **www.solidstateluminaires.com**

BB Rev. **915**

ACCESSORIES

SC-C Straight Connector

Required to connect CornerLine together in a straight linear run.



MC-C Mounting Clip

Single screw mounting clip allows for simple installation. *(Included with the fixture.)*

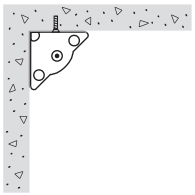
CC Connector Cable *(3' or 6')*

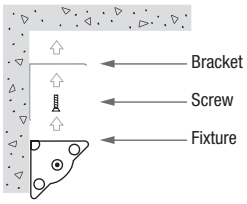
Use connector cables to extend a run, jump from one fixture to another, or as leads from the 4-way and 8-way splitters.

PWR-C Power Button (On fixture)

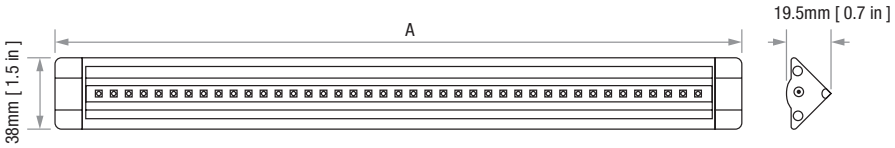
Mounting Height

Mounting Fastener

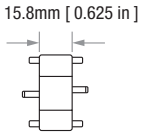




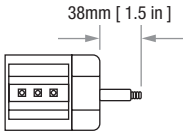
DIMENSIONS



"A" Dimension	
1	300mm [12 in]
2	500mm [20 in]
3	1000mm [39 in]



Straight Connector



Cord Allowance

POWER SUPPLY

PPS Portable Power Supply

The following table illustrates how many fixtures each listed power supply can power.

Power Supply	CNL-1 ft	CNL-2 ft	CNL-3 ft
36W Power Supply	9	6	3

SAFETY INFORMATION

The **CORNERLINE** is for indoor use only.
The LED module is not protected against short circuits, overload or overheating. Therefore you must use an electronically stabilized power supply that offers protection against the previously mentioned safety risks. Our power supplies are specifically designed with protection features for safe operation. If a non Solid State Luminaires power supply is used to power the fixtures, the following basic safety features are required: Short Circuit Protection, Overload Protection, and Overheat Protection.

HARD WIRE POWER SUPPLY

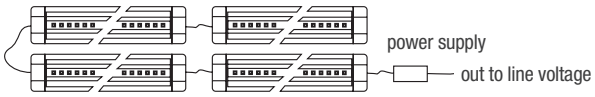
HWS Hard Wire Power Supply

The following table illustrates how many fixtures each listed power supply can power.

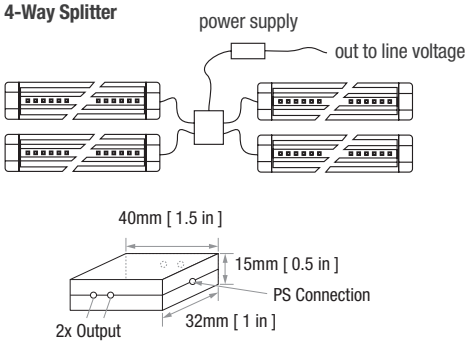
Power Supply	CNL-1 ft	CNL-2 ft	CNL-3 ft
25W Power Supply	6	4	2
50W Power Supply	12	8	4
100W Power Supply	24	16	8

WIRING CONFIGURATIONS

Daisy Chain

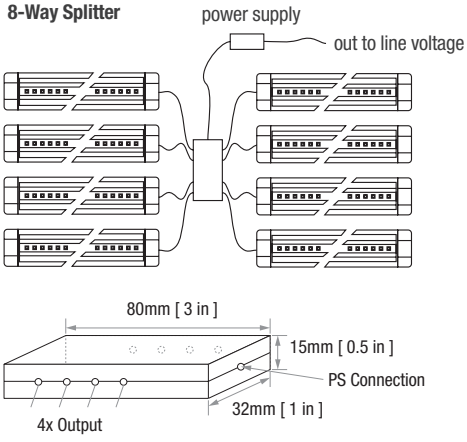


4-Way Splitter



4-Way Splitter *(2 outputs on each side)*

8-Way Splitter



8-Way Splitter *(4 outputs on each side)*

Motion Detector

MD Motion Detector

Technical Features	Diameter	Height	Voltage
Dimensions:	1.9" (48mm)	.47" (12mm)	DC24V

TECHNICAL INFORMATION

Sensor : Photo Infrared

Operating Temperature : -20°C to 40°C

Installation : 2 M3.0x10 screws make it easy to install Input voltage : DC24V

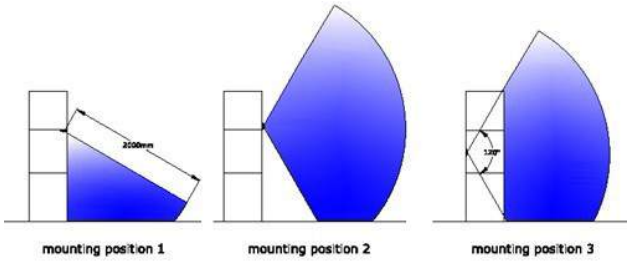
Output voltage : DC24V

Bearing power(max) : 36W

Functional information

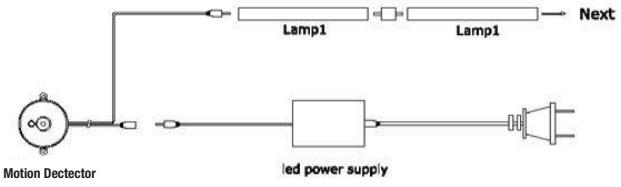
1. Automatic inductive function: when people enter the inductor's effective zone, the Motion Detector will sense activity and lights turn on.
2. Delay closing function: when people leave the inductive zone or people are in the state of rest, the Motion Detector will prolong 30 seconds (time setting is adjustable) and turn lights off.
3. Continuous induction mode: while people are in motion during this setting, the Motion Detector will sense this and the light remains on.
4. The sensitive scope is less than 120 degrees, and the maximum sensitive distance is 2 meters.

Motion Dectector install positions:



Note: this picture shows that the Motion Detector can be installed in different positions, and then the effective zone is different. You may choose correct mounting position according to your purpose.

Standard connection guide:



Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting
L18

High Performance Perimeter Slot (HP-WS)

6"W x 4"D Flat Endcap (shown)

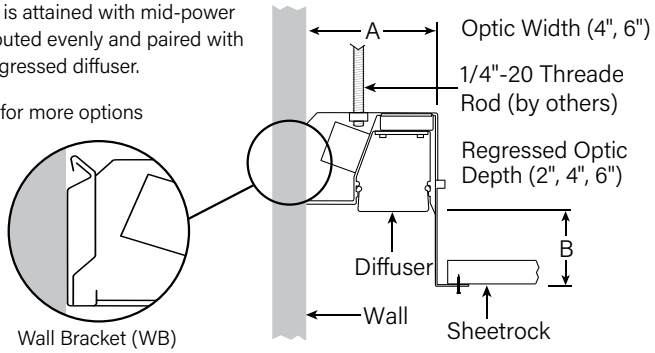
The High Performance Perimeter Slot (HP-WS) creates a wash of ambient and vertical illumination at the transition between the wall and the ceiling plane. Available in 2', 3', 4', & 8' sections with telescoping options that can be combined to make longer runs, and 2", 4", and 6" regressed optic options.

This Product is enrolled in the International Living Future Institute (ILFI) Declare 2.0 Program and is third-party verified with options achieving Red List Approved and Declared status.

CROSS SECTIONS

Distribution is attained with mid-power LEDs distributed evenly and paired with a precise regressed diffuser.

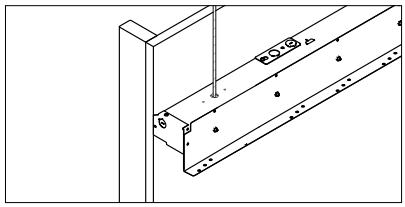
See page 6 for more options



Wall Bracket (WB) Mounting Available

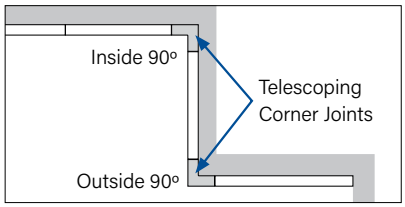
FEATURES

POST-CEILING THREADED-ROD (TR) MOUNTING INSTALLATION



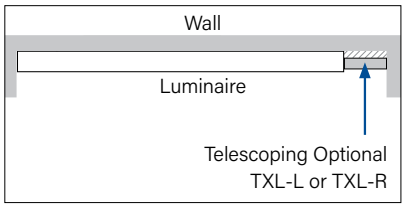
Allows a luminaire to be installed after ceiling framing is complete.

FULLY ILLUMINATED 90º CORNERS



Fully illuminated 90º corners with telescoping standard. Refer to page 3 for telescoping lengths on inside and outside corners.

STRAIGHT RUNS WITH OPTIONAL TELESCOPING



Optional telescoping section adds up to 12 inches for a straight run. Telescope section mounts securely to wall.

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 168
H+B

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

L18 ar Form

High Performance Perimeter Slot (HP-WS)

SEE LIGHTING PLAN FOR LENGTHS

BODY TYPE

Platform	Series Name	Optic Width	Regressed Optic Depth	Total Length of Run
◉ HP - High Performance	◉ WS - Perimeter Slot	◯ 4W - 4" Width ◯ 6W - 6" Width	◯ 2D - 2" Depth ◯ 4D - 4" Depth ◯ 6D - 6" Depth	_____ 2', 3', 4', 8', multiples standard. Telescoping available for fractional lengths

OUTPUT and LED TYPE

Light Output
◯ S - Standard ◯ B - Boosted Standard ◯ H - High ◯ V - Very High ◯ TL - Tailored: _____.m/ft* * Specify lm/ft of outputs between Standard (S) and Very High (V). Consult factory for tailored lumen output outside of this range.

OUTPUT and LED TYPE

LED CRI/CCT
◯ 830 - 80 CRI, 3000K ◯ 835 - 80 CRI, 3500K ◯ 840 - 80 CRI, 4000K ◯ 930 - 90 CRI, 3000K ◯ 935 - 90 CRI, 3500K ◯ 940 - 90 CRI, 4000K ◯ 8TW - 80 CRI, Tunable White ◯ 9TW - 90 CRI, Tunable White

MECHANICAL/OPTICAL OPTIONS

Reflector System
◉ SW - Signal White

ELECTRICAL OPTIONS

Voltage	Circuiting
◯ 120 - 120 Voltage ◯ 277 - 277 Voltage ◯ 347 - 347 Voltage	◯ SC - Single Circuit* One single circuit in a run ◯ MC - Multi-Circuit* More than one switch leg or zone. Factory shop drawings required * Battery, Night Light, and Emergency to Generator circuits are in addition to the normal luminaire circuit(s)

ELECTRICAL OPTIONS

0-10V Driver Options
- ◯ FC-10% - 0-10V 10%[1] (standard)
- ◯ FC-1% - 0-10V 1%[1]
- ◯ OSR-10% - Osram OTi, 0-10V 10%[1]
- ◯ OSR-1% - Osram OTi, 0-10V 1%[1]
- ◯ ELD-10V-0% - EldoLED SOLOdrive, 0-10V 0.1%
- ◯ OSR-10V-TW - Osram OTi, 0-10V 10% *(Tunable White)*[1]

DALI Driver Options
- ◯ FC-DALI-1% - DALI 1%
- ◯ OSR-DALI-1% - Osram Dexal, 1%
- ◯ ELD-DALI-0% - EldoLED SOLOdrive, 0.1%
- ◯ ELD-DALI-TW - EldoLED DUALdrive LightShape, 0.1% *(Tunable White)*

DMX Driver Options
- ◯ FIN-DMX - Finelite DMX 1% *(Tunable White - FineTUNE Controls Only)*[2]
- ◯ ELD-DMX - EldoLED POWERdrive, 0.1%
- ◯ ELD-DMX-TW - EldoLED POWERdrive, 0.1% *(Tunable White)*

Lutron Driver Options
- ◯ LUT-ES1 - Lutron, Ecosystem 1%
- ◯ LUT-2W - Lutron, 2-wire (120V only) 1%
- ◯ LUT-TW - Lutron T-Series, EcoSystem 0.1% *(Tunable White)*

See Page 3 for additional driver options and details

MOUNTING OPTIONS

Mounting Method	Hardware
◯ TR - Threaded Rod[3] ◯ WB - Wall Bracket[4]	◯ C1 - 1" T-Bar ◯ C2 - 9/16" T-Bar ◯ C3 - Screw Slot ◯ SF - Spackle Flange ◯ C1T - 1" Tegular ◯ C2T - 9/16" Tegular

15/16" GRID

OTHER OPTIONS

End Condition Left[5]	End Condition Right[5]	Finish	Emergency Style (Optional)	Sensor (Optional)	Special Options (Optional)
◯ FE-L - Flat Endcap (standard) ◯ PE-L - Pocket Slot ◯ TXL-L - Telescoping	◯ FE-R - Flat Endcap (standard) ◯ PE-R - Pocket Slot ◯ TXL-R - Telescoping	◉ SW - Signal White (standard)	◯ FAC CHO - Factory Choice Battery Back-up ◯ EM/GEN - Emergency to Generator ◯ NL - Night Light ◯ BSL310LP - Bodine Battery Back up Low Profile ◯ GTD - Generator Transfer Device ◯ ALCR - Automatic Load Control Relay	◯ REE - Remote Enlighted[6]	◯ CP - Chicago Plenum[7] ◯ RLA - Red List Approved ◯ RLD - Declared

[1] Add DTO to gain "Dim to Off" functionality (FC-10% - DTO)
[2] B & V outputs only
[3] Pre- or post-ceiling
[4] Pre-ceiling only
[5] The end condition on each side can be specified with different hardware options to accommodate different installation features. See page 3 for more information.
[6] Enlighted Control Unit & Sensor Cable installed for Remote mounting sensor.
[7] Only available with C1, C2, and C3 mounting hardware with Finelite Gridbox

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SUPPLEMENTARY DRIVER PAGE

0-10V Driver Options	
FC-10%	Factory Choice, 0-10V 10% Dimming (Linear)
FC-10%-DTO	Factory Choice, 0-10V 10% Dimming, Dim-to-Off (Linear)
FC-1%	Factory Choice, 0-10V 1% Dimming (Linear)
FC-1%-DTO	Factory Choice, 0-10V 1% Dimming, Dim-to-Off (Linear)
ELD-10V-0%	EldoLED SOLOdrive, 0-10V 0.1% Dimming (Linear)
ELD-10V-1%	EldoLED ECOdrive, 0-10V 1% Dimming (Linear)
OSR-10V-TW	Osram OTi, 0-10V 10% Dimming, *Tunable White* (Linear)
OSR-10V-TW-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off, *Tunable White* (Linear)
OSR-10%	Osram OTi, 0-10V 10% Dimming (Linear)
OSR-10%-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off (Linear)
OSR-1%	Osram OTi, 0-10V 1% Dimming (Linear)
OSR-1%-DTO	Osram OTi, 0-10V 1% Dimming, Dim-to-Off (Linear)

DALI Driver Options	
FC-DALI-1%	Factory Choice, DALI 1% Dimming (Logarithmic)
OSR-DALI-1%	Osram Dexal, DALI 1% Dimming (Logarithmic)
ELD-DALI-0%	EldoLED SOLOdrive, DALI 0.1% Dimming (Logarithmic)
ELD-DALI-1%	EldoLED ECOdrive, DALI 1% Dimming (Logarithmic)
ELD-DALI-TW	EldoLED DUALdrive Light Shape, DALI 0.1% Dimming, *Tunable White* (Logarithmic Dimming, Linear CCT Control)

DMX Driver Options	
FIN-DMX	Finelite, DMX 1% Dimming, *Tunable White* - **FineTUNE Controls Only** (Linear)
ELD-DMX	EldoLED POWERdrive, DMX 0.1% Dimming (8 Bit, 1CH) (Linear)
ELD-DMX-16	EldoLED POWERdrive, DMX 0.1% Dimming (16 Bit, 2CH) (Linear)
ELD-DMX-TW	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (8 Bit, 2CH - CH1 Warm / CH2 Cool) (Linear)
ELD-DMX-TW16	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (16 Bit, 4CH - CH1, 2 Warm / CH3, 4 Cool) (Linear)

Lutron Driver Options	
LUT-ES1	Lutron, Ecosystem 1% Dimming
LUT-2W	Lutron, 2-wire (120V only) 1% Dimming
LUT-TW	Lutron T-Series, EcoSystem 0.1% Dimming, *Tunable White*

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High Performance Perimeter Slot (HP-WS)

SPECIFICATIONS

BODY TYPE

CONSTRUCTION: Precision cut 6061-T6 extruded aluminum visible flange. Internal joiner system, plug-together wiring standard. Steel sheet metal galvanized and powder coated body.

LENGTHS: Standard 2', 3', 4', and 8' section lengths can be combined to make longer runs. Optional telescoping sections on straight runs add a minimum of 1" up to 12" at the end of the luminaire. Contact factory for corner details and availability. Telescoping sections are available on either or both ends of the luminaire.

90º CORNERS : Illuminated 90° inside and outside corners. Standard with telescoping sections. Tapered optics is standard with inside corners.

OUTPUT AND LED TYPE

LIGHT OUTPUT: Four lumen packages available, Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). For lengths 3' and greater, the uplight and downlight can be specified with different lumen packages and dual controls. For Tailored Outputs outside of range from Standard (**S**) to Very High (**V**), consult factory. Light engines are replaceable.

MECHANICAL/OPTICAL OPTIONS

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

REFLECTORS: Finelite Signal White powder coat finish standard.

ELECTRICAL OPTIONS

STATIC WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed controlling uplight and downlight together (power and dimming). Specify dual feeds for independent control of uplight and downlight. 14-gauge feed used when luminaire current exceeds 5 amps.

TUNABLE WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when fixture current exceeds 5 amps. DMX and power feed at same location (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths.

STATIC WHITE DRIVER: Replaceable 120V, 277V, and 347V constant current reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 100%-10% standard. Dimming to 1% available. Separate dimming for uplight and downlight available. Driver is fully accessible from below the ceiling.
- **Power Factor:** ≥ 0.9
- **Total Harmonic Distortion (THD):** <20%
- **Expected driver lifetime:** 100,000 hours

LUTRON STATIC DRIVER OPTIONS:
- **LUTES1 (LDE1)** (Hi-lume 1% EcoSystem with Soft-On, Fade-to-Black dimming (LDE1 series))
- **LUT2W (LTES2W)** (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)).

TUNABLE WHITE DRIVER: Replaceable LED driver. Driver is accessible from below the ceiling. 120V, 277V, and 347V.
- **Power factor:** ≥0.90
- **Total Harmonic Distortion (THD):** <20%
- **Dimming Range:** 100%-10%
- **Expected driver lifetime.:** 100,000 hours
- FineTUNE DMX is 1%

LUTRON TUNABLE WHITE DRIVER OPTION: LUT-TW (0.1% T-Series 2-Channel Digital Tunable White (PSQ Series)).

MOUNTING OPTIONS

HANGING HARDWARE: The standard mounting (Threaded Rod - TR) option eliminates the need to install luminaires prior to the slot being framed. Luminaire mounts on threaded rods. Gasket runs length of luminaire ensuring a clean finish at the wall. Optional mounting includes a wall bracket that is attached to the wall. Luminaires are then snapped onto the bracket. Luminaire installation that uses the mounting bracket must be performed before the perimeter slot framing is built.

TUNABLE WHITE DMX HANGING HARDWARE: For grid ceiling applications the dual GridBox™ mounting is supplied (standard). For hard ceiling applications the ceiling mounting box is supplied (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths. Available DMX pendant feed lengths are 5' (standard), 12', and 30'.

TUNABLE WHITE DMX INTERCONNECTION CABLES: Luminaires are pre-wired with plug-and-play interconnection cables to support easy plug-together joining of fixture runs. If a non-FineTUNE DMX system is specified, a DMX to RJ45 adapter is provided.

OTHER OPTIONS

ENDCAPS: The luminaire can terminate in three different end conditions to accommodate project needs. Endcaps are made of 20-guage die-formed powder-coated steel. Flat (standard) Endcap adds 1/8", Pocket Slot Endcap adds 1-1/4", and for Telescoping Endcap refer to telescoping section below.

END CONDITIONS:
FLAT (standard) (**FE-L** or **FE-R**): Is used when the luminaire terminates at a wall. Adds 1/8" per endcap to overall length of the luminaire.

Continued

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High Performance Perimeter Slot (HP-WS)

SPECIFICATIONS

POCKET SLOT (**PE-L** or **PE-R**): Includes the necessary hardware to accommodate ceiling materials when the luminaire doesn't terminate at a wall. Adds 1-1/4" for Spackle Flange and 1" for T-Bar per endcap to overall length of the luminaire.

TELESCOPING (**TXL-L** or **TXL-R**): Provides up to 12" of additional illuminated section to accommodate variances in the built-in wall slot. Telescoping available on both ends of 4' and 8' luminaire sections. Adds a minimum of 1" per end to overall section length. Telescoping only available at one end of 2' and 3' luminaire sections. Adds a minimum of 2" to overall length of 2' sections and a minimum of 1" to overall length of 3' sections. Telescoping is standard with corners. Telescoping section must end at wall and be secured with bracket (provided).

EMERGENCY STYLE: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, backup battery. Factory-choice low-profile backup battery available. Chicago Plenum Option available (includes telescoping luminaries). 8' minimum luminaire length for low profile battery pack. Backup batteries deliver 1519 lumens. Half of a 4' section will be illuminated in emergency mode. Optional fusing is available.

Tunable White ELECTRICAL OPTIONS[8]:
- **TW Driver Options 0-10V:** EM/GEN, GTD or Battery Back up
- **FineTUNE DMX:** EM/GEN or Battery Back up
- **DMX:** Battery Back up
- **DALI:** EM/GEN, GTD or Battery Back up
- **LUTRON:** EM/GEN, GTD or Battery Back up

FINISHES: Finelite Signal White powder coat finish standard. Optional adder: 185 colors available using RAL color chart. Custom color applies to the visible T-Bar flange.

LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.130 (G), this luminaire contains an internal driver disconnect. UL 924 and UL 2108 - PoE options available on request. IC-Rated. Damp Location. These fixtures are rated for Damp Location. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2015/863. Consult factory for tailored lighting options. Finelite makes the specification process easy when putting healthier products on your projects. Simply add – **RLA** (Red List Approved) or – **RLD** (Declared Label) to your part number.

WEIGHT: 5.6 lb/ft

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

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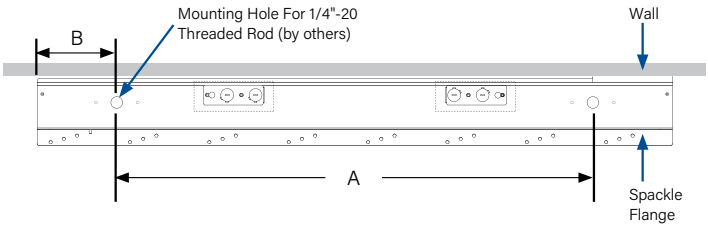
High Performance Perimeter Slot (HP-WS)

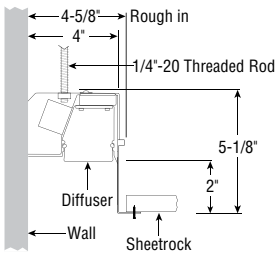
THREADED-ROD (TR) MOUNTING LOCATION



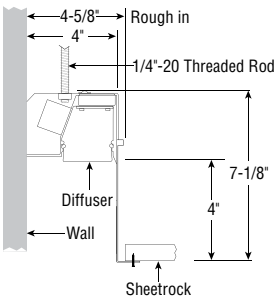
MOUNTING HOLE LOCATION TABLE		
LUMINAIRE LENGTH	A (in)	B (in)
2'	18	3
3'	30	3
4'	36	6
8'	84	6

THREADED-ROD (TR) MOUNTING CROSS SECTIONS

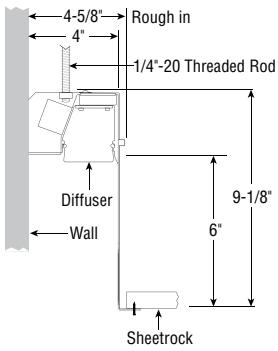
4"W x 2"D



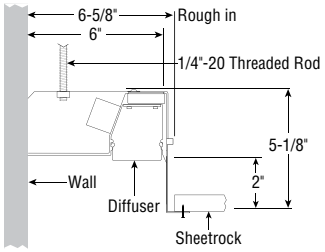
4"W x 4"D



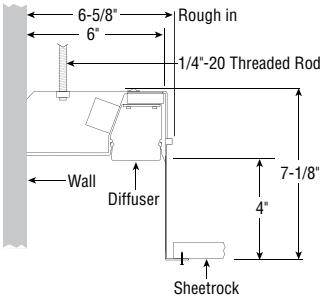
4"W x 6"D



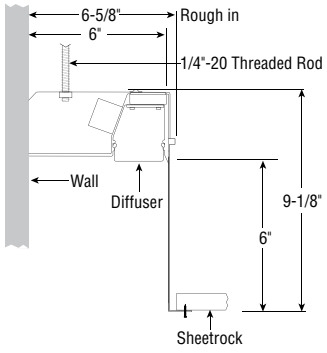
6"W x 2"D



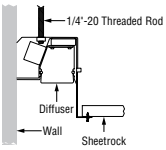
6"W x 4"D



6"W x 6"D



CEILING TYPES — THREADED-ROD (TR) MOUNTING



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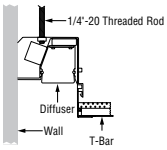
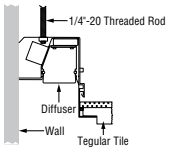
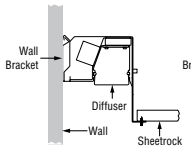


(C1, C2, C3)



(C1T, C2T)

WALL BRACKET (WB) MOUNTING



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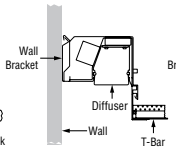
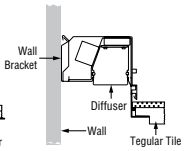


(C1, C2, C3)



(C1T, C2T)

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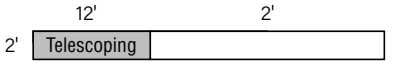
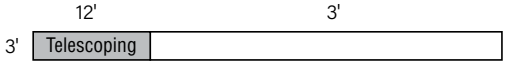
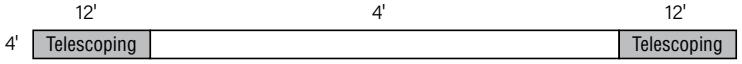
RUN LENGTHS



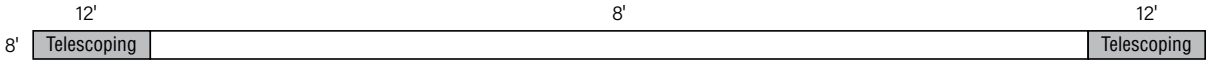
Telescoping Section (optional) adds a minimum of 2" and a maximum of 12". Only one end can be extended.



Telescoping Section (optional) adds a minimum of 1" and a maximum of 12". Only one end can be extended.



Telescoping Sections (optional) adds a minimum of 1" and a maximum of 12". Both ends can be extended.

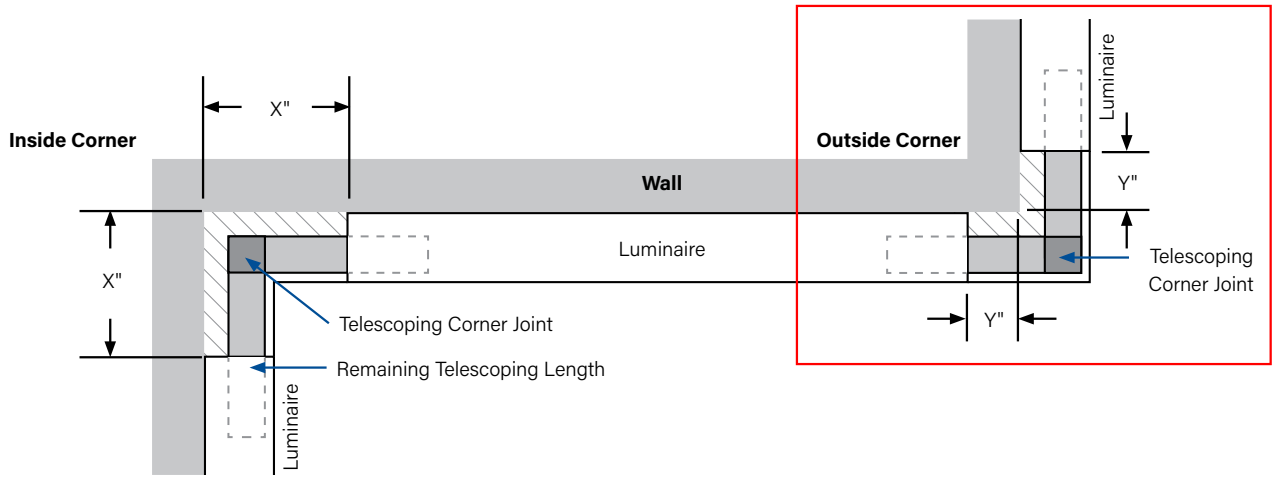


Telescoping Sections (optional) adds a minimum of 1" and a maximum of 12". Both ends can be extended.
Standard 2', 3', 4', and 8' section can be combined to make longer runs.

Endcaps Information
The **Flat Endcap** adds 1/8" per endcap to the section length.
The **Pocket Slot Endcap** adds 1-1/4" for Spackle Flange and 1" for T-Bar per endcap to the section length.

The **Telescoping Endcap** adds:
- A minimum of 2" to a 2' section
- A minimum of 1" to a 3' section
- A minimum of 1" to 4' and 8' sections

90º INSIDE AND OUTSIDE FULLY ILLUMINATED CORNER MEASURING DETAILS



	Measurement From End of Luminaire to Wall			
	Inside Corner		Outside Corner	
Luminaire Width Configuration	X" Min	X" Max	Y" Min	Y" Max
4W	8"	14"	1"	8"
6W	10"	16"	1"	7"

Notes
- Inside and outside corners ship standard with telescoping.
- Telescoping is optional for straight runs.

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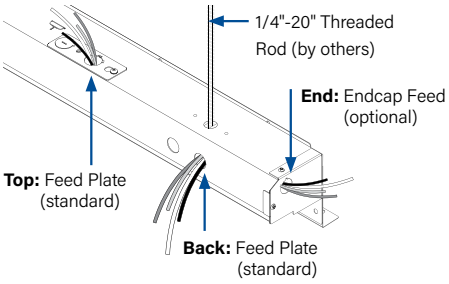
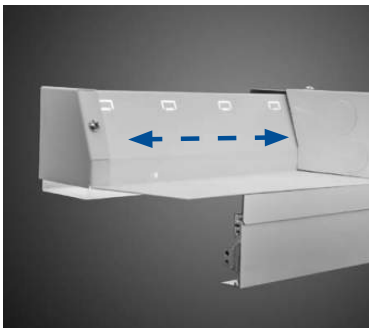
FEED OPTIONS



Refer to installation instructions for feed hole measurements.

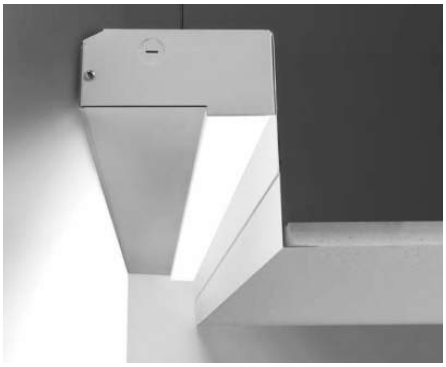
TELESCOPING (TXL-L or TXL-R)



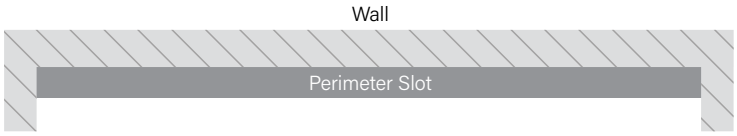
TAPERED OPTIC STANDARD WITH 90º INSIDE CORNERS

ENDCAP OPTIONS

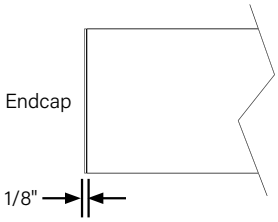
STANDARD FLAT (FE-L or FE-R)



Adds 1/8" per endcap to the section length. Spackle Flange version shown, T-Bar available.

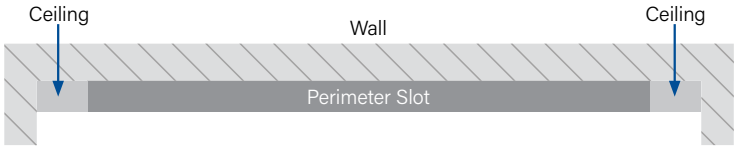


Flat end condition for when luminaire terminates at a vertical surface such as a wall.

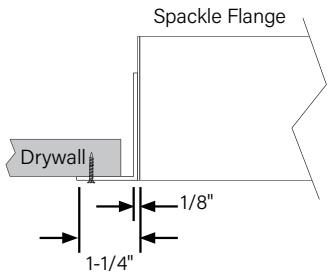


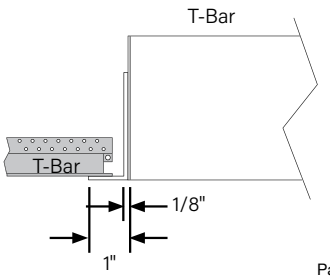
POCKET SLOT (PE-L or PE-R)

Adds 1-1/4" for Spackle Flange and 1" for T-Bar (includes endcap dimension 1/8") per endcap to the housing length on shop drawings. T-Bar version shown, Spackle Flange available.



Pocket slot end condition for when slot terminates before meeting additional vertical wall surface.





Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

L18

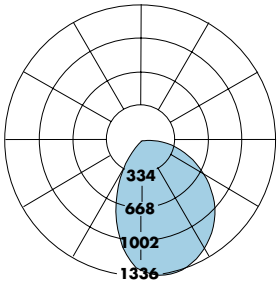
High Performance Perimeter Slot (HP-WS)

Photometry - 4' Luminaire 3500K

4"W x 2"D
Very High Output - 120V
Efficacy: 84 lumens per watt
Total luminaire output: 3097 lumens (774 lm/ft)
37 watts (9.3 W/ft)
Peak Candela Value: 1333 @ 15º

CRI: 80 / CCT: 3500K
ITL LM79 Report 86712

Wall



CandELA distribution

	0.0	45	90	135	180	Flux
0	1235	1235	1235	1235	1235	
5	1280	1264	1229	1198	1168	116
15	1333	1280	1172	1002	903	321
25	1323	1241	1060	746	586	460
35	1258	1150	909	489	297	519
45	1144	1020	735	248	60	502
55	967	859	555	49	2	436
65	741	654	375	3	0	344
75	514	437	204	2	0	233
85	295	232	52	1	0	

Complete LM79 LED Photometry

Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire

	S [1]	B [1]	H [1]	V [2]
4"W x 2"D	1268	1594	2409	3097

Light Output, 3500K, 80 CRI (Lumens Per Foot)

	S [1]	B [1]	H [1]	V [2]
4"W x 2"D	317	398	602	774

Power, 3500K, 80 CRI (Watts Per Foot)

	S [1]	B [1]	H [1]	V [2]
4"W x 2"D	3.6	4.6	7.1	9.3

Efficacy, 3500K, 80 CRI (Lumens Per Watt)

	S [1]	B [1]	H [1]	V [2]
4"W x 2"D	88	87	85	84

Notes
– Refer to LM-79 reports for other configurations.

Sample Lumen Adjustment Calculation

Lumen Adjustment Factors 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

Lumen Adjustment Factors 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

High Output (**H**) 4000K, 90 CRI

Lumen Adjustment Factor: 0.789

Total Light Output: 2409 lm x 0.789 = 1901 lm

Total Light Output per Foot: 602 lm/ft x 0.789 = 475 lm/ft.

watts/foot: 7.1 W/ft.

Efficacy = $\frac{475 \ \frac{\text{lm}}{\text{ft.}}}{7.1 \ \frac{\text{W}}{\text{ft.}}}$ = 67 lm/W

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output
[1] Family Correlation based on 4' luminaire 3500K Very High Output (**V**) test - 120V.
[2] Based on ITL report: 86712

Project		Catalog #		Type	L19
Prepared by		Notes		Date	

Shaper

Shaper Sense™ Trapezoid

Acoustic Lighting
Pendant Luminaire
Suspended Direct/Indirect

Typical Applications
• Office • Education • Healthcare • Hospitality • Retail • Co-working

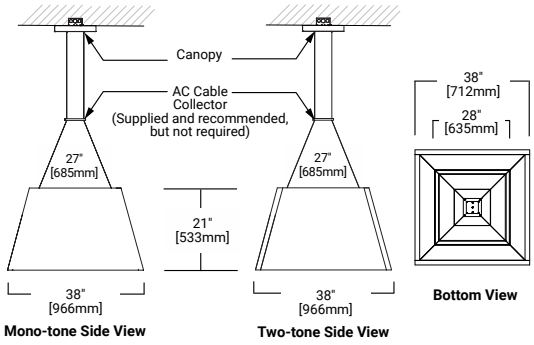
Interactive Menu

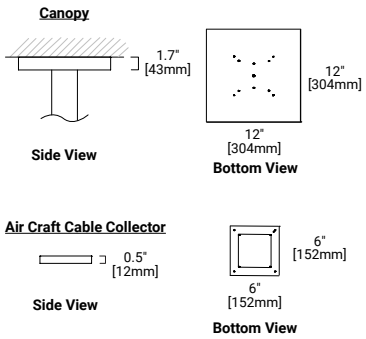
Systems | Certification | Features & Awards

Top Product Features

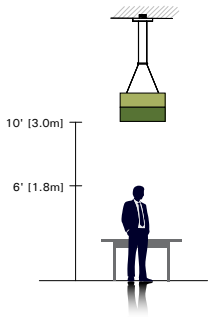
- Shaper Sense is an award winning and patented acoustic lighting product series that merges the concepts of light and sound absorption.
- Lighting is created by an edge-lit square LED panel with an array of patterns that produce uniform visual distribution.
- Sound absorbing acoustic panels are designed with industry leading FilzFelt™ acoustic materials.
- Available in over 60+ vibrant felt colors using 100% Wool Design Felt - 100% recyclable.
- Noise Reduction Coefficient (NRC) = 1.4, Sound Absorption Average (SAA) = 1.38. Learn more at Noise at Work, Knoll - Workplace Research.
- Select pairs of opposing panels in mono-tone or two-tone color choices.

Dimensions





Scale



additional product diagrams

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 177
H+B

Shaper — Shaper Sense Trapezoid

Order Information

L19

FIXTURE NUMBER SAMPLE: **ShSe-TRAP-2-L35-80-UNV-CNPY-STD-AA300-BB170**

Series	Shape / Family	Light Level (Lumens, Wattage, Color Temp, CRI)	Voltage	Mounting	Dimming	Finish	Controls (optional)
ShSe=Shaper Sense	**TRAP**=Trapezoid shaped acoustic light fixture	**1-L30-90**=2487 lumens, 30W, 3000K, 90 CRI **1-L35-80**=3092 lumens, 30W, 3500K, 80 CRI **1-L40-80**=3036 lumens, 30W, 4000K, 80 CRI **2-L30-90**=3181 lumens, 39W, 3000K, 90 CRI **2-L35-80**=3955 lumens, 39W, 3500K, 80 CRI **2-L40-80**=3884 lumens, 39W, 4000K, 80 CRI	**UNV**=Universal Voltage (120-277)	**CNPY**=Canopy mount (works for surface, open structure, and gypsum ceilings)	**STD**=0-10V	(See below and page 3 for panel and color selections)	**SWTPD1**=Wavelinx Wireless Tile Sensor **LWTPD1**=LumaWatt Pro Wireless Tile Sensor
Notes	Notes	**Notes** 3000K – only in 90 CRI, 3500K only available in 80 CRI, 4000K only available in 80 CRI.	Notes	Notes	Notes	COORDINATE WITH ARCHITECT	Notes

Mono-tone Side Panel

Two-tone Side Panel

Finish	
Mono-tone Side Panel	**Two-tone Side Panel**
AA100=AA Wollweiss **AA110**=AA Rohweiss **AA150**=AA Weiss **AA160**=AA Beige **AA170**=AA Asche **AA175**=AA Graphit **AA190**=AA Natur-meliert **AA200**=AA Natur **AA220**=AA Rehbraun **AA250**=AA Truffelbraun **AA300**=AA Anthrazit **AA102**=AA Kirsche **AA105**=AA Rost **AA116**=AA Orange **AA125**=AA Tomate **AA136**=AA Weinrot **AA156**=AA Loden **AA203**=AA Vanille **AA274**=AA Senf **AA312**=AA Lagune **AA331**=AA Sahara **AA385**=AA Schlamm **AA408**=AA Taupe **AA415**=AA Schlif **AA437**=AA Aubergine **AA448**=AA Moos **AA503**=AA Magnolie **AA534**=AA Rose **AA540**=AA Ozean **AA613**=AA Gletsher **AA626**=AA Azur **AA686**=AA Enzian **AA713**=AA Kiwi	**AA732**=AA Farn **AA124**=AA Gelb **AA131**=AA Honig **AA151**=AA Hellorange **AA173**=AA Mango **AA179**=AA Hellrot **AA180**=AA Terracotta **AA201**=AA Rot **AA209**=AA Bordeaux **AA231**=AA Rosa **AA242**=AA Pink **AA255**=AA Flieder **AA265**=AA Lavendel **AA269**=AA Violett **AA272**=AA Royal **AA282**=AA D'Blau **AA284**=AA Himmel **AA286**=AA H'Blau **AA308**=AA Petrol **AA343**=AA D'Grun **AA345**=AA Pazifik **AA377**=AA Maigrun **AA378**=AA Oliv **AA384**=AA Lind **AA411**=AA Alpaka **AA423**=AA Hellgrau **AA425**=AA Taubengrau **AA426**=AA Schwarz **AA467**=AA Sand **AA476**=AA Schoko **AA497**=AA D'Braun **AA533**=AA Indigo **AA548**=AA Turkis	**BB100**=BB Wollweiss **BB110**=BB Rohweiss **BB150**=BB Weiss **BB160**=BB Beige **BB170**=BB Asche **BB175**=BB Graphit **BB190**=BB Natur-meliert **BB200**=BB Natur **BB220**=BB Rehbraun **BB250**=BB Truffelbraun **BB300**=BB Anthrazit **BB102**=BB Kirsche **BB105**=BB Rost **BB116**=BB Orange **BB125**=BB Tomate **BB136**=BB Weinrot **BB156**=BB Loden **BB203**=BB Vanille **BB274**=BB Senf **BB312**=BB Lagune **BB331**=BB Sahara **BB385**=BB Schlamm **BB408**=BB Taupe **BB415**=BB Schlif **BB437**=BB Aubergine **BB448**=BB Moos **BB503**=BB Magnolie **BB534**=BB Rose **BB540**=BB Ozean **BB613**=BB Gletsher **BB626**=BB Azur **BB686**=BB Enzian **BB713**=BB Kiwi	**BB732**=BB Farn **BB124**=BB Gelb **BB131**=BB Honig **BB151**=BB Hellorange **BB173**=BB Mango **BB179**=BB Hellrot **BB180**=BB Terracotta **BB201**=BB Rot **BB209**=BB Bordeaux **BB231**=BB Rosa **BB242**=BB Pink **BB255**=BB Flieder **BB265**=BB Lavendel **BB269**=BB Violett **BB272**=BB Royal **BB282**=BB D'Blau **BB284**=BB Himmel **BB286**=BB H'Blau **BB308**=BB Petrol **BB343**=BB D'Grun **BB345**=BB Pazifik **BB377**=BB Maigrun **BB378**=BB Oliv **BB384**=BB Lind **BB411**=BB Alpaka **BB423**=BB Hellgrau **BB425**=BB Taubengrau **BB426**=BB Schwarz **BB467**=BB Sand **BB476**=BB Schoko **BB497**=BB D'Braun **BB533**=BB Indigo **BB548**=BB Turkis
Notes Selection for TRAP Mono-Tone color side panel. See diagram on page 3 for clarification.		**Notes** Selection for TRAP Two-Tone color side panel. See diagram on page 3 for clarification.	

Product Specifications

Construction
- Light Engine is 6063-T5 extruded aluminum and 20 gauge cold rolled steel frame
- Acoustic Light Fixture is supported with max load 132lb cable
- Weight: 35lbs fully assembled

Electrical
- Standard driver features electronic universal voltage (120-277V/ 50-60 Hz), greater than 0.9 power factor
- Less than 20% harmonic distortion, and ambient temperature of 25˚C (77˚F). 0-10V dimming standard

LED Optics
- Light Engine is 85% transparent
- LPW 100+ in some 3500K and 4000K configurations
- Light Engine offered in 80 CRI for 3500K and 4000K CCTs, and in 90 CRI for 3000K CCT

Mounting
- Acoustic Light Fixture supported by aircraft cable. 12ft adjustable AC cable supplied
- Recommended minimum height of 15' from AC cable collector to Light Engine
- Driver box assembly can mount to any ceiling type: open structure, gyp., or acoustic tile
- Acoustic Light fixture can be supported by junction box supporting 50lb load
- Low voltage cable connects to remote driver box assembly
- AC Cable Collector recommended but not required

Finish
- Light Engine - Housing is white powder coat paint for superior protection against fade and wear
- Acoustic Panels - Over 60+ felt color choices using 100% Wool Design Felt for opposing panels
- Sound absorbing substrate is made of a minimum 60% recycled content and is 100% recyclable

Compliance
- Light Engine components are UL recognized and are cULus listed for 25˚C ambient environments, dry listed
- Acoustic Light Fixture tested per IESNA LM-79
- LM-80 data supplied by LED manufacturer and utilized in TM-21 lumen maintenance projections
- Acoustic Light Fixture tested to ASTM 423C-17 standards and FCC compliant
  - Noise Reduction Coefficient - NRC = 1.4
  - Sound Absorption Average - SAA = 1.38
  - Apparent NRC and SAA values calculated from using total test area occupied by light fixtures

Environment
- Indoor only, dry listing
- 25˚C ambient temperature

Control
- 0-10V dimming standard
- Optional - WaveLinx and Lumawatt Pro wireless control systems

Maintenance
- Cleaning of FilzFelt acoustic materials found here

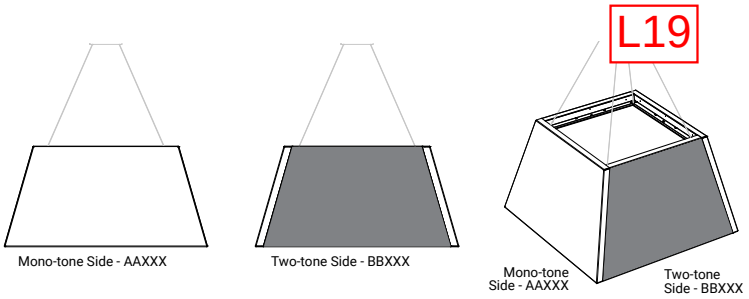
Awards
- Best of NeoCon : Gold
  Lighting: Decorative and Hospitality
- 2019 IES Progress Report, selection
- Architect Magazine Spring 2019, selection
- Architectural SSL Magazine, Product Innovation Award (PIA) 2019
- Architectural Products Magazine, Product Innovation Award (PIA) 2019
- LED Magazine, Sapphire Award Finalist

Warranty
- Five year warranty standard

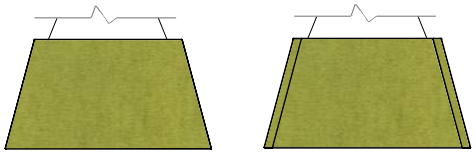
Ordering Information

- Select colors for each opposing panel set.
- For contrasting effects, select a different color for each paired side.
- For a monochromatic effect, select the same color for both pairs of panels.
- For a complete catalog number, select a color for side AA, and a color for side BB.

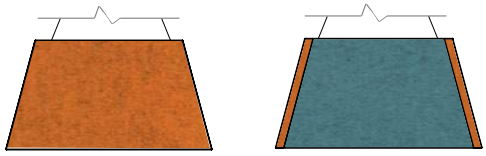
Select AAXXX for Side Panel + Color Selection from chart.
Select BBXXX for Side Panel + Color Selection from chart.
XXX = 3 digit code from FilzFelt color chart options (see below).



EXAMPLE OF MONO-TONE - Side AA = 713 and Side BB = 713 Kiwi



EXAMPLE OF TWO-TONE - Side AA116 = 116 Orange and Side BB312 = 312 Lagune



FILZFELT COLOR CHART OPTIONS

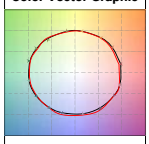
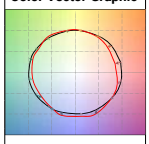
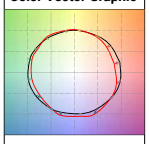
18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 179
H+B

Shaper — Shaper Sense Trapezoid

L19

Photometric Data

SHAPER SENSE - TRAP @ 3000K / 90 CRI		SHAPER SENSE - TRAP @ 3500K / 80 CRI		SHAPER SENSE - TRAP @ 4000K / 80 CRI	
Filename	ShSe-TRAP-2-L30-90-UNV-STD.ies	Filename	ShSe-TRAP-2-L35-80-UNV-STD.ies	Filename	ShSe-TRAP-2-L40-80-UNV-STD.ies
Test No.	P316062	Test No.	P316063	Test No.	P316064
Lumcat	ShSe-TRAP-2-L30-90-UNV-STD	Lumcat	ShSe-TRAP-2-L35-80-UNV-STD	Lumcat	ShSe-TRAP-2-L40-80-UNV-STD
Lumens	3181 Lm	Lumens	3955 Lm	Lumens	3884 Lm
Watts	38.8 W	Watts	38.8 W	Watts	38.8 W
LPW	82 Lm/W	LPW	101.9 Lm/W	LPW	100.1 Lm/W
CCT	3000K	CCT	3500K	CCT	4000K
SC (0/90/45)	2.4 / 1.51 / 1.84	SC (0/90/45)	2.4 / 1.51 / 1.84	SC (0/90/45)	2.4 / 1.51 / 1.84
Color Vector Graphic		Color Vector Graphic		Color Vector Graphic	
TM-30-15		TM-30-15		TM-30-15	
R_f	91.7	R_f	81	R_f	81
R_g	99.7	R_g	95.9	R_g	95.9
59% up 41% down		59% up 41% down		59% up 41% down	

Lumen Maintenance

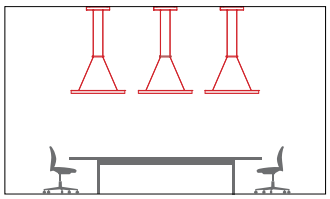
Ambient Temperature	Lumen Maintenance: TM-21 (60,000 Hours)	Theoretical L70 (Hours)
25°C	> 89%	> 60,000

Accoustic Analysis - Reverberation Decrease

Reverberation Time example. Acoustic test reports available by request.

RT60 : Light Fixtures without sound absorption

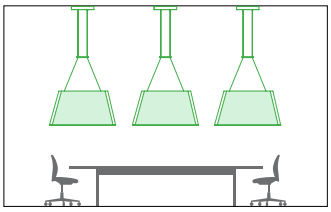
Frequency (Hz)						Avg
125	250	500	1000	2000	4000	250-2k
0.76	0.97	1.15	1.11	0.91	0.85	1.04



6 fixture comparison

RT60 : Light Fixtures with sound absorption

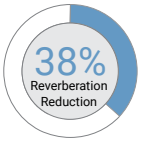
Frequency (Hz)						Avg
125	250	500	1000	2000	4000	250-2k
0.64	0.75	0.68	0.6	0.53	0.52	0.64



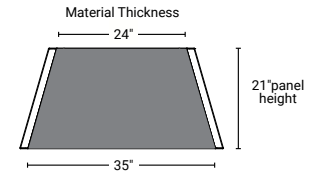
% Improvement in Reverberation (RT60)

Frequency (Hz)						Avg
125	250	500	1000	2000	4000	250-2k
16%	23%	41%	46%	42%	39%	38%

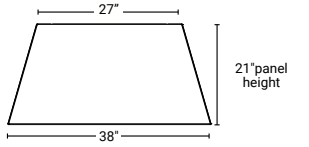
Ex. 38% Reverberation decrease (RT60) using 6 Shaper Sense Trapezoid fixtures.



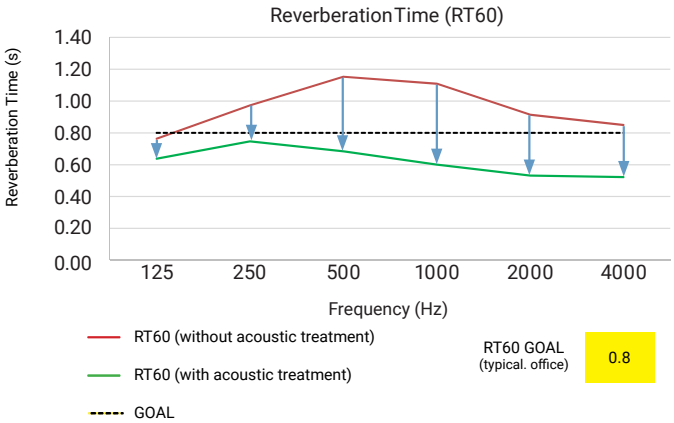
Reverberation: prolongation of a sound; resonance.
Reverberation Time (RT60): Reverberation time is a measure of the time required for the sound to decay or sound pressure level to reduce by 60 dB.



Acoustic panel thickness is 1.49" thick. Two sides of the panels are 24"L x 35"W x 21"H and 1.49" deep.



Acoustic panel thickness is 1.49" thick. Two sides of the panels are 27"L x 38"W x 21"H and 1.49" deep.



Connected Control (Optional)

L19

WaveLinx (SWPD1) Wireless Sensor LumaWatt Pro (LWIPD1) Ordering Information.

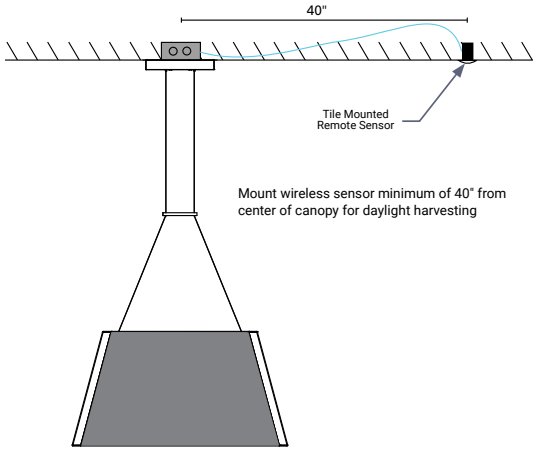
Product Family	Occupancy Technology	Sensing Technology	Coverage Pattern
SWT = WaveLinx Wireless Sensor **LWT** = LumaWatt Pro Wireless Sensor	**P** = Passive Infrared	**D** = Dimming Daylight Harvesting (Closed Loop)	**1** = ~ 144 Square Feet

WaveLinx
The WaveLinx Tilemount sensor option is an integral part of the WaveLinx Wireless Connected Lighting System. It offers 3 amp relay control and continuous 0-10V dimming of Shaper Sense luminaires. The tilemount sensor provides daylight dimming and control for a single luminaire or can be daisy chained for group luminaire control. The sensor's control module allows simple electrical junction box mounting via a ½" knockout or direct connection to the junction box attached to the Shaper luminaire. The WaveLinx Tilemount sensor operates on a wireless mesh network based on IEEE 802.15.4 standards and is controlled by a WaveLinx Wireless Area Controller.

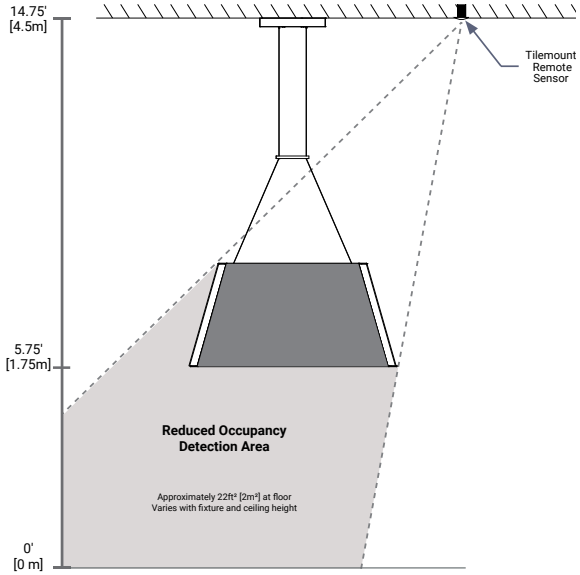
LumaWatt Pro
The LumaWatt Pro Tilemount sensor option is field installed to a single luminaire's junction box or daisy chained to a group of luminaires, providing lighting control and sensing in an independent, fault-proof, resilient network of powerful end-points. Sensors have profiles stored internally containing all of the variables for the application once a configuration is set and is able to manage the fixture without connectivity to the system. The sensors gather data from four on-board inputs: Passive infrared occupancy detection, daylight, temperature, and electrical current use. Wireless gateways communicate with the sensors and transmit the data using industry-standard wired technology to the Energy Manager, for powerful, familiar dashboards of information tailored for access on a connected computer. Energy Managers connect to optional cloud-based applications, maximizing the dense, data-rich sensing within the footprint of the luminaire for management of the building environment, and much more.

Sensor Mounting and Coverage

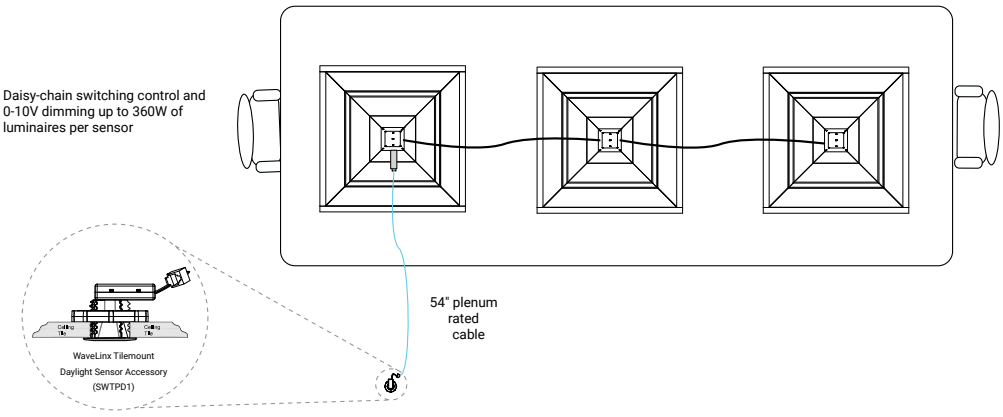
Daylight Harvesting - Recommended mounting



Occupancy Detection - Coverage



Wireless Sensor Example Layout



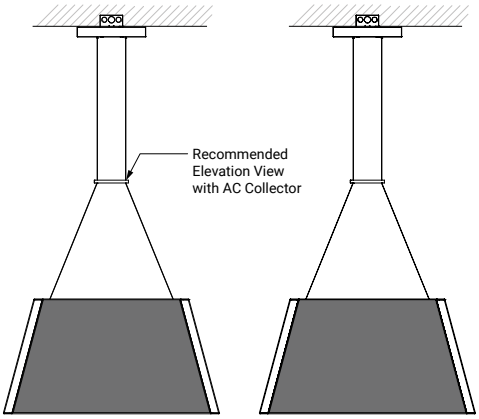
18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 181
H+B

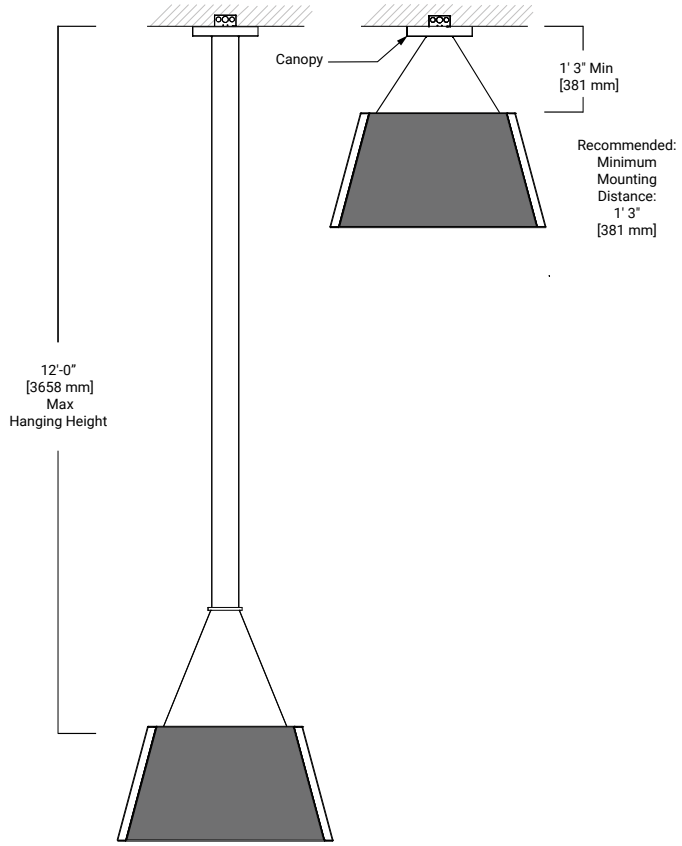
Mounting Information and Recommendations

L19

Collector is recommended but not required



Maximum and Minimum Hanging Heights



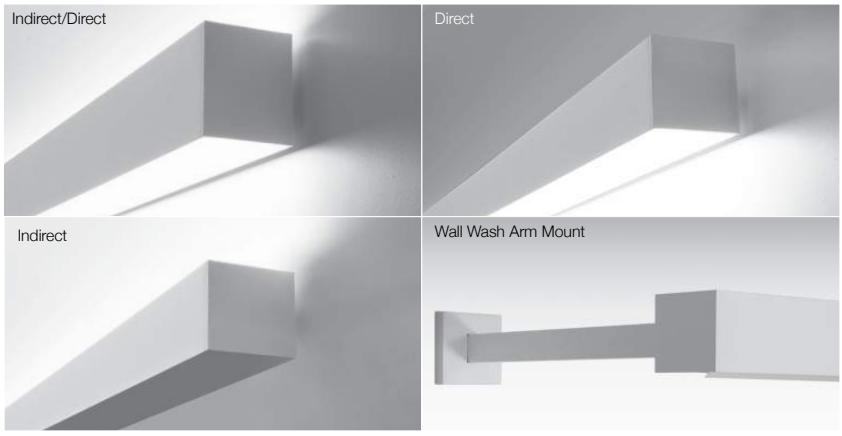
Cooper Lighting Solutions
18001 East Colfax Avenue
Aurora, CO 80011
P: 303-393-1522
www.eaton.com/lighting

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L20A

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount



High Performance 4" Aperture Wall Mount family includes Indirect/Direct, Direct, Indirect, and Wall Wash Arm Mount luminaires. HP-4 delivers excellent performance using an advanced optical design and mid-power LEDs to achieve 90% of initial light output at 100,000+ hours.

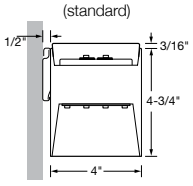
This product is enrolled in the International Living Future Institute (ILFI) Declare 2.0 Program and is third-party verified with options achieving **Red List Approved** and **Declared** status.

Signal White is standard finish

Note: see page 6 for all aesthetic options

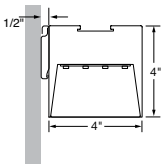
CROSS SECTIONS

Indirect/Direct
Top Glow Diffuser (standard)



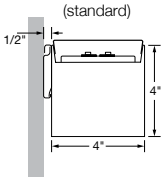
Flush Downlight Diffuser (standard)

Direct

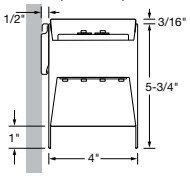


Flush Downlight Diffuser (standard)

Indirect
Top Glow Diffuser (standard)

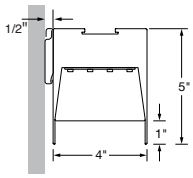


Indirect/Direct Regressed
Top Glow Diffuser (standard)



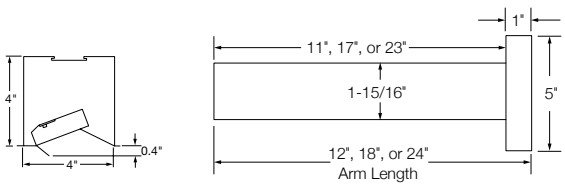
Flat Diffuser with 1" Regress (standard)

Direct Regressed



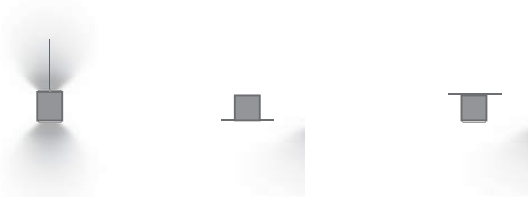
Flush Downlight Diffuser (standard)

Wall Wash Arm Mount



Kicker (standard)

ALSO AVAILABLE IN



Pendant (**D, ID, I**)

Recessed (**R**)

Surface Mount (**SM**)

Option Available

Protected by one or more US Patents: 8915613; D702,391; D702,390; D700,732

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 183
H+B

Submitted by:	Date:
Type:	Project:
Ordering Info:	

FINELITE® Better Lighting

L20A

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

BODY TYPE

Platform	Series Name	Luminaire Type	Luminaire Distribution	Total Length of Run
◉ **HP** - High Performance	◉ **4**	◯ **WM** - Wall Mount [1] ◯ **WM RG** - Wall Mount Regressed [1] ◯ **AM** - Arm Mount (Wall Wash only)	◯ **D** - Direct ◯ **WW-D** - Wall Wash Direct ◯ **ID** - Indirect/Direct ◯ **I** - Indirect	2'-0" Minimum 2' section length. Increments accurate to 1/16" (±1/32"), standard. 12' maximum section length.

OUTPUT and LED TYPE

Uplight Output ID & I Only (Flush)	Downlight Output ID & D Only (Flush)
◯ **S** - Standard (428 lm/ft)	◯ **S** - Standard (379 lm/ft)
◯ **B** - Boosted (538 lm/ft)	◯ **B** - Boosted (477 lm/ft)
◯ **H** - High (813 lm/ft)	◯ **H** - High (721 lm/ft)
◯ **V** - Very High (1045 lm/ft)	◯ **V** - Very High (927 lm/ft)
◯ **TL** - Tailored:_____lm/ft*	◯ **TL** - Tailored:_____lm/ft*

* Specify lm/ft of outputs between Standard (S) and Very High (V). Consult factory for tailored lumen output outside of this range.

MECHANICAL/OPTICAL OPTIONS

LED CRI/CCT	Uplight Optics ID & I Only	Downlight Optics ID & D Only	Reflector System
◯ **830** - 80 CRI, 3000K ◯ **835** - 80 CRI, 3500K ◯ **840** - 80 CRI, 4000K ◯ **930** - 90 CRI, 3000K ◯ **935** - 90 CRI, 3500K ◯ **940** - 90 CRI, 4000K ◯ **8TW** - 80 CRI, Tunable White ◯ **9TW** - 90 CRI, Tunable White	◯ **TG** - Top Glow (standard) ◯ **F** - Flush ◯ **ASY-L** - Asymmetric Left Optic ◯ **ASY-R** - Asymmetric Right Optic ◯ **ASYTG-L** - Asymmetric Left Optic with Top Glow ◯ **ASYTG-R** - Asymmetric Right Optic with Top Glow	◯ **F** - Flush (standard) [1] ◯ **BG** - Bottom Glow [1] ◯ **DL** - 1" Drop Down Lens [1] ◯ **RG-D** - Flat Diffuser with 1" Regress [1, 2] ◯ **RG-WCB** - White Cross Blade Baffle [1, 2] ◯ **RG-LHE** - Hollowed Ellipse Louver [1, 2] ◯ **RG-LHC** - Hex Louver [1, 2] ◯ **K** - Kicker for Wall Wash only (standard) ◯ **FO** - Fully Open for Wall Wash only	◯ **96LG** - 96 Low Gloss White ◯ **SSA** - Semi-Specular Aluminum for Wall Wash only

ELECTRICAL OPTIONS

Voltage
◯ **120** - 120 Voltage ◯ **277** - 277 Voltage ◯ **347** - 347 Voltage

ELECTRICAL OPTIONS

Circuiting [3]	Driver Selection
◯ **SC** - Single Circuit* One single circuit in a run ◯ **DC** - Dual Circuit* [4] Independent control of up and down separately in an I/D style fixture ◯ **MC** - Multi-Circuit* More than one switch leg or zone. Factory shop drawings required * Battery, Night Light, and Emergency to Generator circuits are in addition to the normal luminaire circuit(s)	**0-10V Driver Options** ◯ **FC-10%** - 0-10V 10% [5] (standard) ◯ **FC-1%** - 0-10V 1% [5] ◯ **OSR-10%** - Osram OTi, 0-10V 10% [5] ◯ **OSR-1%** - Osram OTi, 0-10V 1% [5] ◯ **ELD-10V-0%** - EldoLED SOLOdrive, 0-10V 0.1% ◯ **OSR-10V-TW** - Osram OTi, 0-10V 10% *(Tunable White)* [5] **DALI Driver Options** ◯ **FC-DALI-1%** - DALI 1% ◯ **OSR-DALI-1%** - Osram Dexal, 1% ◯ **ELD-DALI-0%** - EldoLED SOLOdrive, 0.1% ◯ **ELD-DALI-TW** - EldoLED DUALdrive LightShape, 0.1% *(Tunable White)* **DMX Driver Options** ◯ **FIN-DMX** - Finelite DMX 1% *(Tunable White - FineTune Controls Only)* [6] ◯ **ELD-DMX** - EldoLED POWERdrive, 0.1% ◯ **ELD-DMX-TW** - EldoLED POWERdrive, 0.1% *(Tunable White)* **Lutron Driver Options** ◯ **LUT-ES1** - Lutron, Ecosystem 1% ◯ **LUT-2W** - Lutron, 2-wire (120V only) 1% ◯ **LUT-TW** - Lutron T-Series, EcoSystem 0.1% *(Tunable White)* See Page 3 for additional driver options and details

MOUNTING OPTIONS

Mounting Method
◯ **MB** - Mounting Bracket [7] ◯ **AM12** - 12" [8] ◯ **AM18** - 18" [8] ◯ **AM24** - 24" [8]

OTHER OPTIONS

Endcap Style	Finish	Emergency Style (Optional)	Integrated Sensor (Optional)	Special Options (Optional)
◯ **FE** - Flat Endcap (standard) ◯ **DE** - 1" Drop Endcap [9] ◯ **OE** - Open Endcap [10]	◯ **SW** - Signal White (standard) ◯ **FB** - Finelite Black [11] ◯ **SA** - Satin Aluminum [11] ◯ **####** - RAL Color Code [11] _____	◯ **FAC CHO** - Factory Choice Battery Back-up ◯ **EM/GEN** - Emergency to Generator ◯ **NL** - Night Light ◯ **BSL722** - Bodine Battery Back up ◯ **BSL310LP** - Bodine Battery Back up Low Profile ◯ **GTD** - Generator Transfer Device	◯ **OBO** - Occupancy [1] ◯ **OBD** - Daylight [1] ◯ **OBE** - Enlighted [1, 12] ◯ **REE** - Remote Enlighted [12]	◯ **RLA** - Red List Approved ◯ **RLD** - Declared

TBD by architect

[1] Not available for Wall Wash
[2] Regressed only
[3] Contact factory for switching options
[4] Indirect/Direct only
[5] Add DTO to gain "Dim to Off" functionality (FC-10% - DTO)
[6] B & V outputs only
[7] Wall Mount only
[8] Arm
[9] 1" D
[10] Available with Hollowed Ellipse Louver (**LHE**) only
[11] 20 business days lead time for color
[12] Enlighted components installed by Finelite, provided by others
[13] Enlighted for Wall Wash fixtures. Enlighted Control Unit & Sensor Cable installed for Remote mounting sensor

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

L20A

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

SUPPLEMENTARY DRIVER PAGE

0-10V Driver Options	
FC-10%	Factory Choice, 0-10V 10% Dimming (Linear)
FC-10%-DTO	Factory Choice, 0-10V 10% Dimming, Dim-to-Off (Linear)
FC-1%	Factory Choice, 0-10V 1% Dimming (Linear)
FC-1%-DTO	Factory Choice, 0-10V 1% Dimming, Dim-to-Off (Linear)
ELD-10V-0%	EldoLED SOLOdrive, 0-10V 0.1% Dimming (Linear)
ELD-10V-1%	EldoLED ECOdrive, 0-10V 1% Dimming (Linear)
OSR-10V-TW	Osram OTi, 0-10V 10% Dimming, *Tunable White* (Linear)
OSR-10V-TW-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off, *Tunable White* (Linear)
OSR-10%	Osram OTi, 0-10V 10% Dimming (Linear)
OSR-10%-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off (Linear)
OSR-1%	Osram OTi, 0-10V 1% Dimming (Linear)
OSR-1%-DTO	Osram OTi, 0-10V 1% Dimming, Dim-to-Off (Linear)

DALI Driver Options	
FC-DALI-1%	Factory Choice, DALI 1% Dimming (Logarithmic)
OSR-DALI-1%	Osram Dexal, DALI 1% Dimming (Logarithmic)
ELD-DALI-0%	EldoLED SOLOdrive, DALI 0.1% Dimming (Logarithmic)
ELD-DALI-1%	EldoLED ECOdrive, DALI 1% Dimming (Logarithmic)
ELD-DALI-TW	EldoLED DUALdrive Light Shape, DALI 0.1% Dimming, *Tunable White* (Logarithmic Dimming, Linear CCT Control)

DMX Driver Options	
FIN-DMX	Finelite, DMX 1% Dimming, *Tunable White* - **FineTUNE Controls Only** (Linear)
ELD-DMX	EldoLED POWERdrive, DMX 0.1% Dimming (8 Bit, 1CH) (Linear)
ELD-DMX-16	EldoLED POWERdrive, DMX 0.1% Dimming (16 Bit, 2CH) (Linear)
ELD-DMX-TW	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (8 Bit, 2CH - CH1 Warm / CH2 Cool) (Linear)
ELD-DMX-TW16	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (16 Bit, 4CH - CH1, 2 Warm / CH3, 4 Cool) (Linear)

Lutron Driver Options	
LUT-ES1	Lutron, Ecosystem 1% Dimming
LUT-2W	Lutron, 2-wire (120V only) 1% Dimming
LUT-TW	Lutron T-Series, EcoSystem 0.1% Dimming, *Tunable White*

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L20A

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

SPECIFICATIONS

BODY TYPE

CONSTRUCTION: Precision-cut 6061-T6 extruded aluminum body. Internal joiner system, plug-together wiring, standard.

LENGTHS: Any length, 2' minimum, in increments down to 1/16" (±1/32"). 12' maximum section length. Hollowed Ellipse Louver (**LHE**), Hex Louver (**LHC**), and White Cross Blade Baffle (**WCB**) are available in 1' increments.

MITERED CORNERS [1]: Illuminated corners of greater than 60° and less than 180° in a single plane, available with Flush Diffuser, Bottom Glow Diffuser, 1" Drop Down Lens, Regressed Diffuser, White Cross Blade Baffle[2] or Wall Wash. Corners not available with Wall Wash (**WW-D**), Hollowed Ellipse Louver (**LHE**) or Hex Louver (**LHC**). Contact factory for Double miters using the White Cross Blade Baffle. Consult factory for tailored lighting options.

OUTPUT AND LED TYPE

LIGHT OUTPUT: Four lumen packages available, Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). For lengths 3' and greater, the uplight and downlight can be specified with different lumen packages and dual controls. For Tailored Outputs outside of range from Standard (**S**) to Very High (**V**), consult factory. Light engines are replaceable.

MECHANICAL/OPTICAL OPTIONS

UPLIGHT OPTION [4]: Patented Top Glow frost white diffuser standard. 12 ft. maximum diffuser length. 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination Optional: Flush frost white snap-in diffuser, 73% transmissive, 99% diffusion; **ASY-L** distributes light to the left, **ASY-R** distributed light to the right of the luminaire. Consult factory for more tailored lumen outputs.

DOWNLIGHT OPTION [5]: 12' maximum diffuser length. Flush frost white snap-in diffuser standard, 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination. Available with Flush (**F**), Bottom Glow (**BG**), 1" Drop Down Lens (**DL**), White Cross Blade Baffle (**WCB**) [6], Hollowed Ellipse Louver (**LHE**) [6], Hex Louver (**LHC**) [6], and Regressed downlight diffusers (**RG**). 1" Drop Down Lens made of highly efficient acrylic. Available with a solid endcap or an endcap with a diffuse filler to continue the luminous aesthetic. Consult factory for more tailored lumen outputs.

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

REFLECTORS: Wall Mount: Die-formed 20-gauge cold-rolled steel reflectors finished in 96LG High Reflectance white powder coat paint. **Arm Mount**: The standard Semi-Specular Aluminum (**SSA**) Kicker (**K**) reflector delivers light high on the vertical surface. The Kicker reflector can be easily removed for open distribution (**FO**).

ELECTRICAL FEATURES

STATIC WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed controlling uplight and downlight together (power and dimming). Specify dual feeds for independent control of uplight and downlight. 14- gauge feed used when luminaire current exceeds 5 amps.

TUNABLE WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when luminaire current exceeds 5 amps. DMX and power feed at same location (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths.

STATIC WHITE DRIVER: Replaceable 120V, 277V, and 347V Constant Current Reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 10%- 100% standard. Dimming to 1% available. Separate dimming for uplight and downlight available. Driver is fully accessible from below the ceiling.
- **Power Factor:** ≥ 0.9
- **Total Harmonic Distortion (THD):** <20%
- **Expected driver lifetime:** 100,000 hours

LUTRON DRIVER OPTIONS:
- **LUT-ES1 (LDE1)** - (Hi-lume 1% EcoSystem with Soft-On, Fade-to-Black dimming (LDE1 series)).
- **LUT-2W (LTEA2W)** - (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)).

TUNABLE WHITE DRIVER: Replaceable LED driver. Driver is accessible from below the ceiling. 120V, 277V, and 347V.
- **Power factor:** ≥0.90
- **Total Harmonic Distortion (THD):** <20%
- **Dimming Range:** 100%-10%
- **Expected driver lifetime.:** 100,000 hours
- **FineTune DMX:** 1%

LUTRON TUNABLE WHITE DRIVER OPTION: LUT-TW (1% T-Series 2-Channel Digital Tunable White (PSQ Series)).

[1] Not available with Wall Wash
[2] Indirect/Direct and Direct only
[3] White Cross Blade (WCB) baffles not available with custom angles. Available in 90 degrees only
[4] Wall Mount Indirect/Direct, Wall Mount Regressed Indirect/Direct, and Wall Mount Indirect only
[5] Wall Mount Indirect/Direct, Wall Mount Regressed Indirect/Direct, Wall Mount Direct, and Wall Mount Regressed Direct only
[6] Wall Mount Regressed Indirect/Direct & Wall Mount Regressed Direct only

Continued

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L20A

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

SPECIFICATIONS

MOUNTING OPTIONS

HANGING HARDWARE: Wall Mount: Luminaire hangs securely from mounting brackets fastened directly to the wall for easy installation. Luminaire stands 1/2" off the wall. The mounting bracket is concealed behind the luminaire. **Arm Mount**: bracket mounts directly to wall j-box, extends luminaire 12", 18", or 24" from wall. Other lengths available. Consult factory.

TUNABLE WHITE DMX HANGING HARDWARE: For grid ceiling applications the dual GridBox™ mounting is supplied (standard). For hard ceiling applications the ceiling mounting box is supplied (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths. Available DMX pendant feed lengths are 5' (standard), 12', and 30'.

TUNABLE WHITE DMX INTERCONNECTION CABLES: Luminaires are pre-wired with plug-and-play interconnection cables to support easy plug-together joining of luminaire runs. If a non-FineTune DMX system has been specified, a DMX to RJ45 converter is provided.

OTHER OPTIONS

ENDCAPS: Flat diecast aluminum endcaps (**FE**) add 1/4" to each end of luminaire. 1" Drop Down Lens Endcap (**DE**)[7] includes diffuse element to continue luminance of drop lens. Open Endcap (**OE**) is for use with the Hollowed Ellipse Louver (**LHE**); following the curve of the louver.

EMERGENCY STYLE: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, step-dimming driver, backup battery.

Backup Battery

	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-WM-D			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'
HP4-WM-WW-D			
Min. Housing Length	8'*	4'*	4'*
EM Lumen Output	2000	1189	2000
EM Section Illum.	4'	4'	4'
HP4-WM-ID			
Min. Housing Length	8'*	4'*	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'

* Minimum fixture housing length for battery pack approved without sensor

Backup Battery * Minimum fixture housing length for battery pack approved without sensor

	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-WM-I			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	2057	1222	2057
EM Section Illum.	2'	2' or 4'	2'

TUNABLE WHITE ELECTRICAL OPTIONS[8]:
- **TW Driver Options 0-10V:** EM/GEN, GTD or Battery Back up
- **FineTune DMX:** EM/GEN or Battery Back up
- **DMX:** Battery Back up
- **DALI:** EM/GEN, GTD or Battery Back up
- **LUTRON:** EM/GEN, GTD or Battery Back up

INTEGRATED SENSORS: Integrated PIR (Passive Infrared) occupancy or daylight sensors available with Flush and Bottom Glow downlight diffusers. Refer to Occupancy Sensor, Daylight Sensor, and Enlighted Sensor tech sheets for more info.

FINISHES: Finelite Signal White (**SW**) powder coat, Finelite Black (RAL 9005) with semi gloss fine texture (**FB**)[9], and Satin Aluminum (**SA**)[9] are standard. Optional Adder: 185 RAL colors[9] are available.

LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.130 (G), this luminaire contains an internal driver disconnect. UL 924 and UL 2108 - PoE options available on request. These fixtures are rated for Damp Location. Chicago Plenum options available for C1, C2, or C3 suspension using our GridBox. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2015/863. Consult factory for tailored lighting options. Finelite makes the specification process easy when putting healthier products on your projects. Simply add – **RLA** (Red List Approved) or – **RLD** (Declared Label) to your part number.

WEIGHT[10]: ID - 3.4 lb/ft; D - 2.8 lb/ft; I - 2.8 lb/ft; AM - 2.9 lb/ft (luminaire only)

DLC QUALIFIED: Configurations of this product are listed on the DLC Qualified Products List (QPL). www.designlights.org/search

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

[7] Available in Indirect/Direct Regressed & Direct Regressed only
[8] Consult Finelite for Generator Transfer Device and Battery Backup fit
[9] 20 business days lead time for color
[10] Excludes Battery Back up and Generator Transfer Device weight

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
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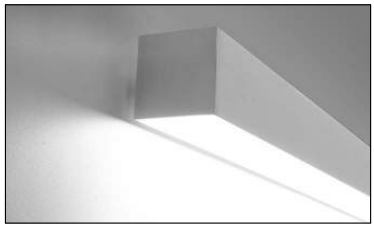
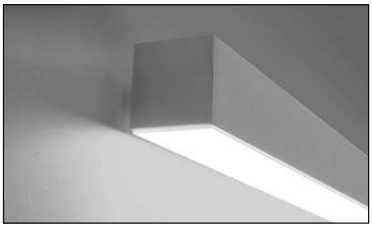
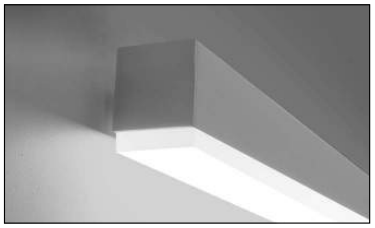
High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

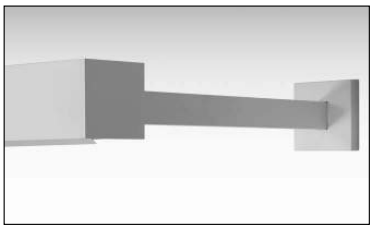
AESTHETIC OPTIONS


Flush Diffuser (**F**)

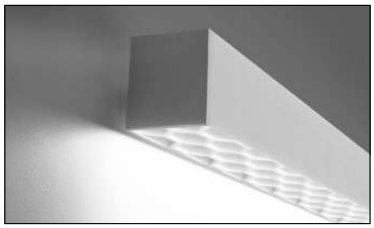

Bottom Glow Diffuser (**BG**)

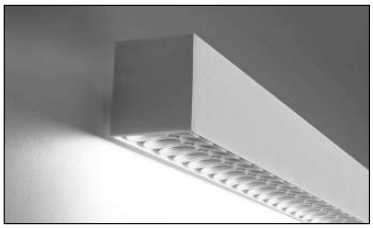

1" Drop Down Lens (**DL**)


Flat Diffuser with 1" Regressed (**RG-D**)


Kicker (**K**) - Wall Wash Arm Mount only


White Cross Blade Baffle[1] (**RG-WCB**)

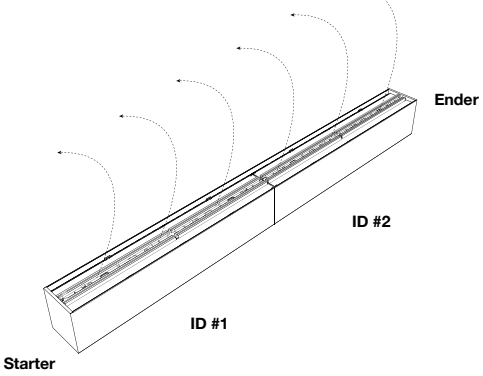

Hex Louver[1] (**RG-LHC**)


Hollowed Ellipse Louver[1] (**RG-LHE**)

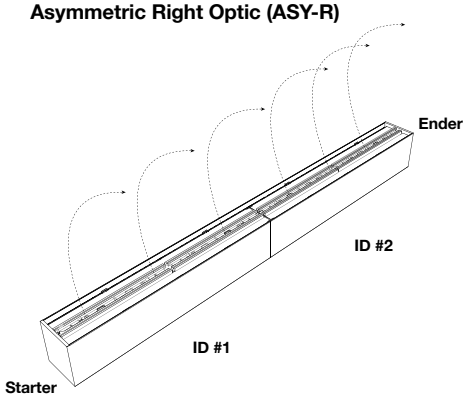
ASYMMETRIC OPTIONS

Use this tool to understand how to specify Asymmetric for your project. The diagrams below show a linear run from power feed to ender. Specify, ASY-L distributes light to the left or ASY-R distributed light to the right.

Asymmetric Left Optic (ASY-L)



Asymmetric Right Optic (ASY-R)



[1] Not available with Wall Wash

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

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Better Lighting

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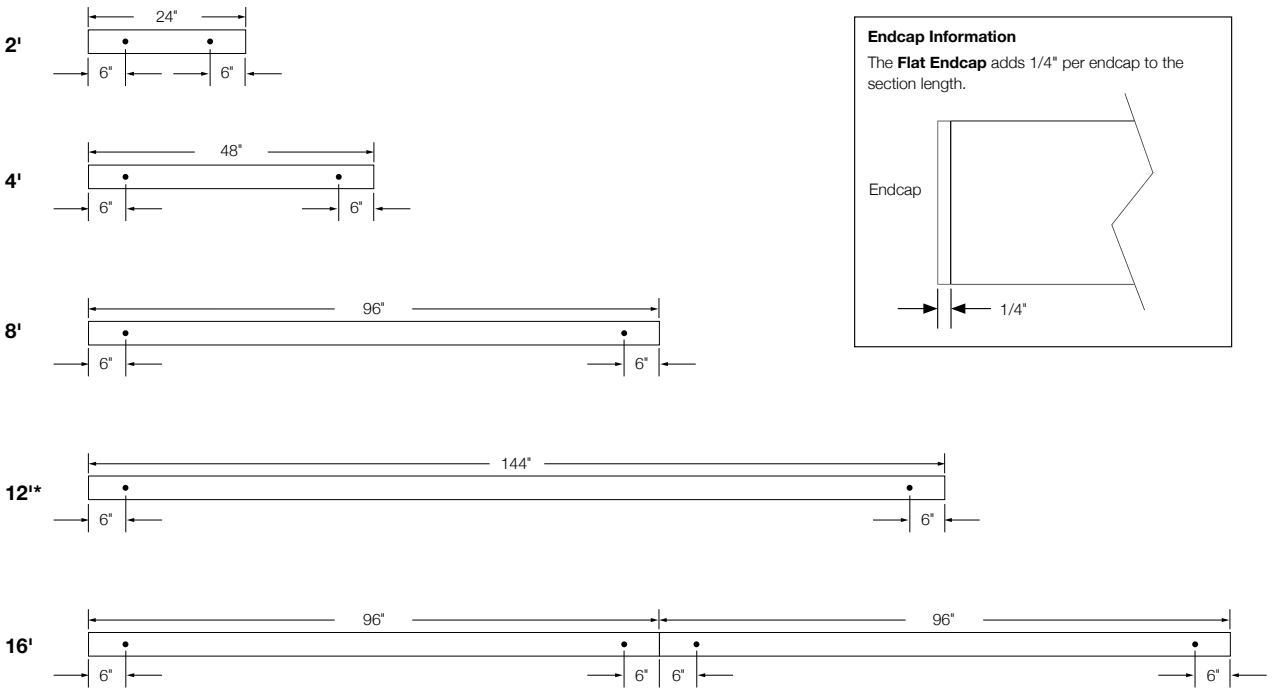
High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

WALL WASH ARM MOUNT - Run Lengths & Mounting Location Examples

Tailored Lengths Available Down To 1/16" (±1/32")



Endcap Information

The **Flat Endcap** adds 1/4" per endcap to the section length.

• = Bracket Location
* = 12' Maximum spacing for two Arm Mount supports

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Type:	Project:
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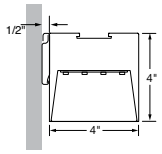
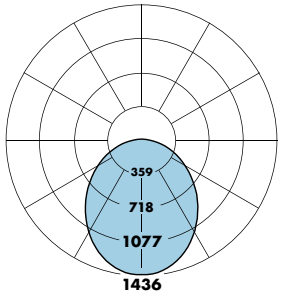
High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

Direct Photometry - 4' Luminaire 3500K

HP4-WM-D-4'-V-835
Downlight: Flush Diffuser





CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0	FLUX
0	1436	1436	1436	1436	1436	
5	1428	1428	1427	1427	1427	135
15	1363	1353	1358	1357	1350	382
25	1236	1221	1226	1219	1212	563
35	1060	1047	1048	1037	1030	653
45	859	849	848	836	831	652
55	647	639	637	628	623	568
65	434	432	431	425	424	425
75	236	236	237	235	236	250
85	67	68	69	70	69	77
90	0	0	0	0	0	

Efficacy: 100 lm/W
Total luminaire output: 3705 lumens (926 lm/ft)
37 watts (9.3 W/ft)
Peak Candela Value: 1436 @ 0°
CRI: 80 / CCT: 3500K
ITL LM79 Report 85124

Complete LM79 LED Photometry

Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire			
S [1]	**B** [1]	**H** [1]	**V** [2]
1517	1907	2882	3705

Light Output, 3500K, 80 CRI (Lumens Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
379	477	720	926

Power, 3500K (Watts Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
3.6	4.6	7.1	9.3

Efficacy, 3500K, 80 CRI (Lumens Per Watt)			
S [1]	**B** [1]	**H** [1]	**V** [2]
105	107	102	100

Sample Lumen Adjustment Calculation

Lumen Adjustment Factors 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

Lumen Adjustment Factors 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

High Output (**H**), 4000K, 90 CRI

Lumen Adjustment Factor: 0.789

Total Light Output: 2882 lm x 0.789 = 2274 lm

Total Light Output per Foot: 720 lm/ft x 0.789 = 568 lm/ft.

watts/foot: 7.1 W/ft.

$$\textbf{Efficacy} = \frac{568\ \frac{\text{lm}}{\text{ft.}}}{7.1\ \frac{\text{W}}{\text{ft.}}} = 80\ \text{lm/W}$$

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output

[1] Family Correlation based on 4' luminaire 3500K Very High Output (**V**) test - 120V.
[2] Based on ITL report: 85124

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
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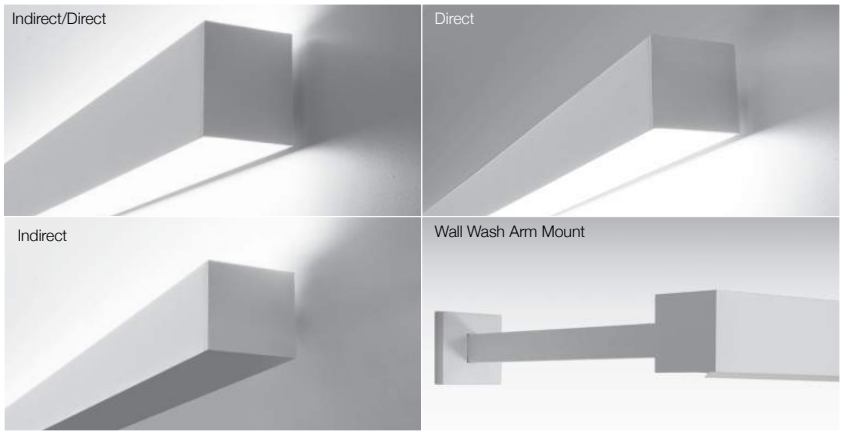
High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount



High Performance 4" Aperture Wall Mount family includes Indirect/Direct, Direct, Indirect, and Wall Wash Arm Mount luminaires. HP-4 delivers excellent performance using an advanced optical design and mid-power LEDs to achieve 90% of initial light output at 100,000+ hours.

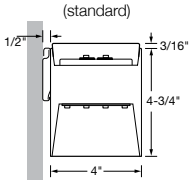
This product is enrolled in the International Living Future Institute (ILFI) Declare 2.0 Program and is third-party verified with options achieving **Red List Approved** and **Declared** status.

Signal White is standard finish

Note: see page 6 for all aesthetic options

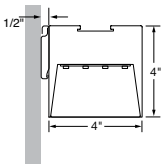
CROSS SECTIONS

Indirect/Direct
Top Glow Diffuser (standard)



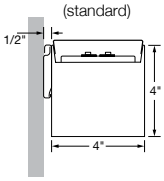
Flush Downlight Diffuser (standard)

Direct

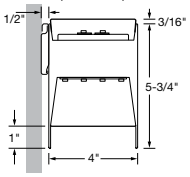


Flush Downlight Diffuser (standard)

Indirect
Top Glow Diffuser (standard)

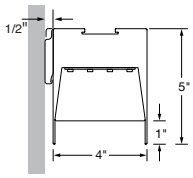


Indirect/Direct Regressed
Top Glow Diffuser (standard)



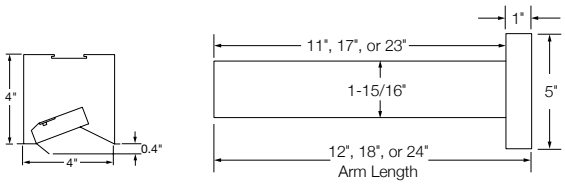
Flat Diffuser with 1" Regress (standard)

Direct Regressed



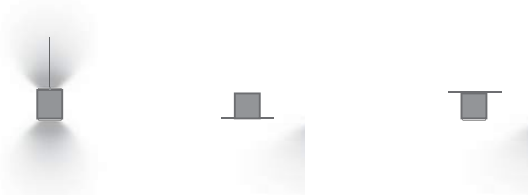
Flush Downlight Diffuser (standard)

Wall Wash Arm Mount



Kicker (standard)

ALSO AVAILABLE IN



Pendant (**D, ID, I**)

Recessed (**R**)

Surface Mount (**SM**)

Option Available

A brand of legrand

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 191
H+B

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

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High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

BODY TYPE

Platform	Series Name	Luminaire Type	Luminaire Distribution	Total Length of Run
◉ **HP** - High Performance	◉ **4**	◯ **WM** - Wall Mount [1] ◯ **WM RG** - Wall Mount Regressed [1] ◯ **AM** - Arm Mount (Wall Wash only)	◯ **D** - Direct ◯ **WW-D** - Wall Wash Direct ◯ **ID** - Indirect/Direct ◯ **I** - Indirect	2'-0" Minimum 2' section length. Increments accurate to 1/16" (±1/32"), standard. 12' maximum section length.

OUTPUT and LED TYPE

Uplight Output ID & I Only (Flush)	Downlight Output ID & D Only (Flush)
◯ **S** - Standard (428 lm/ft)	◯ **S** - Standard (379 lm/ft)
◯ **B** - Boosted (538 lm/ft)	◯ **B** - Boosted (477 lm/ft)
◯ **H** - High (813 lm/ft)	◯ **H** - High (721 lm/ft)
◯ **V** - Very High (1045 lm/ft)	◯ **V** - Very High (927 lm/ft)
◯ **TL** - Tailored:_____lm/ft*	◯ **TL** - Tailored:_____lm/ft*

* Specify lm/ft of outputs between Standard (S) and Very High (V). Consult factory for tailored lumen output outside of this range.

MECHANICAL/OPTICAL OPTIONS

LED CRI/CCT	Uplight Optics ID & I Only	Downlight Optics ID & D Only	Reflector System
◯ **830** - 80 CRI, 3000K ◯ **835** - 80 CRI, 3500K ◯ **840** - 80 CRI, 4000K ◯ **930** - 90 CRI, 3000K ◯ **935** - 90 CRI, 3500K ◯ **940** - 90 CRI, 4000K ◯ **8TW** - 80 CRI, Tunable White ◯ **9TW** - 90 CRI, Tunable White	◯ **TG** - Top Glow (standard) ◯ **F** - Flush ◯ **ASY-L** - Asymmetric Left Optic ◯ **ASY-R** - Asymmetric Right Optic ◯ **ASYTG-L** - Asymmetric Left Optic with Top Glow ◯ **ASYTG-R** - Asymmetric Right Optic with Top Glow	◯ **F** - Flush (standard) [1] ◯ **BG** - Bottom Glow [1] ◯ **DL** - 1" Drop Down Lens [1] ◯ **RG-D** - Flat Diffuser with 1" Regress [1, 2] ◯ **RG-WCB** - White Cross Blade Baffle [1, 2] ◯ **RG-LHE** - Hollowed Ellipse Louver [1, 2] ◯ **RG-LHC** - Hex Louver [1, 2] ◯ **K** - Kicker for Wall Wash only (standard) ◯ **FO** - Fully Open for Wall Wash only	◯ **96LG** - 96 Low Gloss White ◯ **SSA** - Semi-Specular Aluminum for Wall Wash only

ELECTRICAL OPTIONS

Voltage
◯ **120** - 120 Voltage ◯ **277** - 277 Voltage ◯ **347** - 347 Voltage

ELECTRICAL OPTIONS

Circuiting [3]	Driver Selection
◯ **SC** - Single Circuit* One single circuit in a run ◯ **DC** - Dual Circuit* [4] Independent control of up and down separately in an I/D style fixture ◯ **MC** - Multi-Circuit* More than one switch leg or zone. Factory shop drawings required * Battery, Night Light, and Emergency to Generator circuits are in addition to the normal luminaire circuit(s)	**0-10V Driver Options** ◯ **FC-10%** - 0-10V 10% [5] (standard) ◯ **FC-1%** - 0-10V 1% [5] ◯ **OSR-10%** - Osram OTi, 0-10V 10% [5] ◯ **OSR-1%** - Osram OTi, 0-10V 1% [5] ◯ **ELD-10V-0%** - EldoLED SOLOdrive, 0-10V 0.1% ◯ **OSR-10V-TW** - Osram OTi, 0-10V 10% *(Tunable White)* [5] **DALI Driver Options** ◯ **FC-DALI-1%** - DALI 1% ◯ **OSR-DALI-1%** - Osram Dexal, 1% ◯ **ELD-DALI-0%** - EldoLED SOLOdrive, 0.1% ◯ **ELD-DALI-TW** - EldoLED DUALdrive LightShape, 0.1% *(Tunable White)* **DMX Driver Options** ◯ **FIN-DMX** - Finelite DMX 1% *(Tunable White - FineTune Controls Only)* [6] ◯ **ELD-DMX** - EldoLED POWERdrive, 0.1% ◯ **ELD-DMX-TW** - EldoLED POWERdrive, 0.1% *(Tunable White)* **Lutron Driver Options** ◯ **LUT-ES1** - Lutron, Ecosystem 1% ◯ **LUT-2W** - Lutron, 2-wire (120V only) 1% ◯ **LUT-TW** - Lutron T-Series, EcoSystem 0.1% *(Tunable White)* See Page 3 for additional driver options and details

MOUNTING OPTIONS

Mounting Method
◯ **MB** - Mounting Bracket [7] ◯ **AM12** - 12" [8] ◯ **AM18** - 18" [8] ◯ **AM24** - 24" [8]

OTHER OPTIONS

Endcap Style	Finish	Emergency Style (Optional)	Integrated Sensor (Optional)	Special Options (Optional)
◯ **FE** - Flat Endcap (standard) ◯ **DE** - 1" Drop Endcap [9] ◯ **OE** - Open Endcap [10]	◯ **SW** - Signal White (standard) ◯ **FB** - Finelite Black [11] ◯ **SA** - Satin Aluminum [11] ◯ **####** - RAL Color Code [11] _____	◯ **FAC CHO** - Factory Choice Battery Back-up ◯ **EM/GEN** - Emergency to Generator ◯ **NL** - Night Light ◯ **BSL722** - Bodine Battery Back up ◯ **BSL310LP** - Bodine Battery Back up Low Profile ◯ **GTD** - Generator Transfer Device	◯ **OBO** - Occupancy [1] ◯ **OBD** - Daylight [1] ◯ **OBE** - Enlighted [1, 12] ◯ **REE** - Remote Enlighted [12]	◯ **RLA** - Red List Approved ◯ **RLD** - Declared

TBD by architect

[1] Not available for Wall Wash
[2] Regressed only
[3] Contact factory for switching options
[4] Indirect/Direct only
[5] Add DTO to gain "Dim to Off" functionality (FC-10% - DTO)
[6] B & V outputs only
[7] Wall Mount only
[8] Arm
[9] 1" D
[10] Available with Hollowed Ellipse Louver (**LHE**) only
[11] 20 business days lead time for color
[12] Enlighted components installed by Finelite, provided by others
[13] Enlighted for Wall Wash fixtures. Enlighted Control Unit & Sensor Cable installed for Remote mounting sensor

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE® Better Lighting

L20B

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

SUPPLEMENTARY DRIVER PAGE

0-10V Driver Options	
FC-10%	Factory Choice, 0-10V 10% Dimming (Linear)
FC-10%-DTO	Factory Choice, 0-10V 10% Dimming, Dim-to-Off (Linear)
FC-1%	Factory Choice, 0-10V 1% Dimming (Linear)
FC-1%-DTO	Factory Choice, 0-10V 1% Dimming, Dim-to-Off (Linear)
ELD-10V-0%	EldoLED SOLOdrive, 0-10V 0.1% Dimming (Linear)
ELD-10V-1%	EldoLED ECOdrive, 0-10V 1% Dimming (Linear)
OSR-10V-TW	Osram OTi, 0-10V 10% Dimming, *Tunable White* (Linear)
OSR-10V-TW-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off, *Tunable White* (Linear)
OSR-10%	Osram OTi, 0-10V 10% Dimming (Linear)
OSR-10%-DTO	Osram OTi, 0-10V 10% Dimming, Dim-to-Off (Linear)
OSR-1%	Osram OTi, 0-10V 1% Dimming (Linear)
OSR-1%-DTO	Osram OTi, 0-10V 1% Dimming, Dim-to-Off (Linear)

DALI Driver Options	
FC-DALI-1%	Factory Choice, DALI 1% Dimming (Logarithmic)
OSR-DALI-1%	Osram Dexal, DALI 1% Dimming (Logarithmic)
ELD-DALI-0%	EldoLED SOLOdrive, DALI 0.1% Dimming (Logarithmic)
ELD-DALI-1%	EldoLED ECOdrive, DALI 1% Dimming (Logarithmic)
ELD-DALI-TW	EldoLED DUALdrive Light Shape, DALI 0.1% Dimming, *Tunable White* (Logarithmic Dimming, Linear CCT Control)

DMX Driver Options	
FIN-DMX	Finelite, DMX 1% Dimming, *Tunable White* - **FineTUNE Controls Only** (Linear)
ELD-DMX	EldoLED POWERdrive, DMX 0.1% Dimming (8 Bit, 1CH) (Linear)
ELD-DMX-16	EldoLED POWERdrive, DMX 0.1% Dimming (16 Bit, 2CH) (Linear)
ELD-DMX-TW	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (8 Bit, 2CH - CH1 Warm / CH2 Cool) (Linear)
ELD-DMX-TW16	EldoLED POWERdrive, DMX 0.1% Dimming, *Tunable White* (16 Bit, 4CH - CH1, 2 Warm / CH3, 4 Cool) (Linear)

Lutron Driver Options	
LUT-ES1	Lutron, Ecosystem 1% Dimming
LUT-2W	Lutron, 2-wire (120V only) 1% Dimming
LUT-TW	Lutron T-Series, EcoSystem 0.1% Dimming, *Tunable White*

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L20B

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

SPECIFICATIONS

BODY TYPE

CONSTRUCTION: Precision-cut 6061-T6 extruded aluminum body. Internal joiner system, plug-together wiring, standard.

LENGTHS: Any length, 2' minimum, in increments down to 1/16" (±1/32"). 12' maximum section length. Hollowed Ellipse Louver (**LHE**), Hex Louver (**LHC**), and White Cross Blade Baffle (**WCB**) are available in 1' increments.

MITERED CORNERS [1]: Illuminated corners of greater than 60° and less than 180° in a single plane, available with Flush Diffuser, Bottom Glow Diffuser, 1" Drop Down Lens, Regressed Diffuser, White Cross Blade Baffle[2] or Wall Wash. Corners not available with Wall Wash (**WW-D**), Hollowed Ellipse Louver (**LHE**) or Hex Louver (**LHC**). Contact factory for Double miters using the White Cross Blade Baffle. Consult factory for tailored lighting options.

OUTPUT AND LED TYPE

LIGHT OUTPUT: Four lumen packages available, Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). For lengths 3' and greater, the uplight and downlight can be specified with different lumen packages and dual controls. For Tailored Outputs outside of range from Standard (**S**) to Very High (**V**), consult factory. Light engines are replaceable.

MECHANICAL/OPTICAL OPTIONS

UPLIGHT OPTION [4]: Patented Top Glow frost white diffuser standard. 12 ft. maximum diffuser length. 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination Optional: Flush frost white snap-in diffuser, 73% transmissive, 99% diffusion; **ASY-L** distributes light to the left, **ASY-R** distributed light to the right of the luminaire. Consult factory for more tailored lumen outputs.

DOWNLIGHT OPTION [5]: 12' maximum diffuser length. Flush frost white snap-in diffuser standard, 73% transmissive, 99% diffusion. Internal secondary diffusers at corners ensure visually seamless, uniform, continuous illumination. Available with Flush (**F**), Bottom Glow (**BG**), 1" Drop Down Lens (**DL**), White Cross Blade Baffle (**WCB**) [6], Hollowed Ellipse Louver (**LHE**) [6], Hex Louver (**LHC**) [6], and Regressed downlight diffusers (**RG**). 1" Drop Down Lens made of highly efficient acrylic. Available with a solid endcap or an endcap with a diffuse filler to continue the luminous aesthetic. Consult factory for more tailored lumen outputs.

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

REFLECTORS: Wall Mount: Die-formed 20-gauge cold-rolled steel reflectors finished in 96LG High Reflectance white powder coat paint. **Arm Mount**: The standard Semi-Specular Aluminum (**SSA**) Kicker (**K**) reflector delivers light high on the vertical surface. The Kicker reflector can be easily removed for open distribution (**FO**).

ELECTRICAL FEATURES

STATIC WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed controlling uplight and downlight together (power and dimming). Specify dual feeds for independent control of uplight and downlight. 14- gauge feed used when luminaire current exceeds 5 amps.

TUNABLE WHITE FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when luminaire current exceeds 5 amps. DMX and power feed at same location (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths.

STATIC WHITE DRIVER: Replaceable 120V, 277V, and 347V Constant Current Reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 10%- 100% standard. Dimming to 1% available. Separate dimming for uplight and downlight available. Driver is fully accessible from below the ceiling.
- **Power Factor:** ≥ 0.9
- **Total Harmonic Distortion (THD):** <20%
- **Expected driver lifetime:** 100,000 hours

LUTRON DRIVER OPTIONS:
- **LUT-ES1 (LDE1)** - (Hi-lume 1% EcoSystem with Soft-On, Fade-to-Black dimming (LDE1 series)).
- **LUT-2W (LTEA2W)** - (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)).

TUNABLE WHITE DRIVER: Replaceable LED driver. Driver is accessible from below the ceiling. 120V, 277V, and 347V.
- **Power factor:** ≥0.90
- **Total Harmonic Distortion (THD):** <20%
- **Dimming Range:** 100%-10%
- **Expected driver lifetime.:** 100,000 hours
- **FineTune DMX:** 1%

LUTRON TUNABLE WHITE DRIVER OPTION: LUT-TW (1% T-Series 2-Channel Digital Tunable White (PSQ Series)).

[1] Not available with Wall Wash
[2] Indirect/Direct and Direct only
[3] White Cross Blade (WCB) baffles not available with custom angles. Available in 90 degrees only
[4] Wall Mount Indirect/Direct, Wall Mount Regressed Indirect/Direct, and Wall Mount Indirect only
[5] Wall Mount Indirect/Direct, Wall Mount Regressed Indirect/Direct, Wall Mount Direct, and Wall Mount Regressed Direct only
[6] Wall Mount Regressed Indirect/Direct & Wall Mount Regressed Direct only

Continued

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

FINELITE®
Better Lighting

L20B

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

SPECIFICATIONS

MOUNTING OPTIONS

HANGING HARDWARE: Wall Mount: Luminaire hangs securely from mounting brackets fastened directly to the wall for easy installation. Luminaire stands 1/2" off the wall. The mounting bracket is concealed behind the luminaire. **Arm Mount**: bracket mounts directly to wall j-box, extends luminaire 12", 18", or 24" from wall. Other lengths available. Consult factory.

TUNABLE WHITE DMX HANGING HARDWARE: For grid ceiling applications the dual GridBox™ mounting is supplied (standard). For hard ceiling applications the ceiling mounting box is supplied (standard). DMX feeds cannot be cut or spliced. DMX feeds should be ordered based on fixed lengths. Available DMX pendant feed lengths are 5' (standard), 12', and 30'.

TUNABLE WHITE DMX INTERCONNECTION CABLES: Luminaires are pre-wired with plug-and-play interconnection cables to support easy plug-together joining of luminaire runs. If a non-FineTune DMX system has been specified, a DMX to RJ45 converter is provided.

OTHER OPTIONS

ENDCAPS: Flat diecast aluminum endcaps (**FE**) add 1/4" to each end of luminaire. 1" Drop Down Lens Endcap (**DE**)[7] includes diffuse element to continue luminance of drop lens. Open Endcap (**OE**) is for use with the Hollowed Ellipse Louver (**LHE**); following the curve of the louver.

EMERGENCY STYLE: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, step-dimming driver, backup battery.

Backup Battery

	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-WM-D			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'
HP4-WM-WW-D			
Min. Housing Length	8'*	4'*	4'*
EM Lumen Output	2000	1189	2000
EM Section Illum.	4'	4'	4'
HP4-WM-ID			
Min. Housing Length	8'*	4'*	4'*
EM Lumen Output	1854	1102	1854
EM Section Illum.	2'	2' or 4'	2'

* Minimum fixture housing length for battery pack approved without sensor

Backup Battery * Minimum fixture housing length for battery pack approved without sensor

	Factory Choice	Bodine BSL310LP	Bodine BSL722
HP4-WM-I			
Min. Housing Length	8'	4'	4'*
EM Lumen Output	2057	1222	2057
EM Section Illum.	2'	2' or 4'	2'

TUNABLE WHITE ELECTRICAL OPTIONS[8]:
- **TW Driver Options 0-10V:** EM/GEN, GTD or Battery Back up
- **FineTune DMX:** EM/GEN or Battery Back up
- **DMX:** Battery Back up
- **DALI:** EM/GEN, GTD or Battery Back up
- **LUTRON:** EM/GEN, GTD or Battery Back up

INTEGRATED SENSORS: Integrated PIR (Passive Infrared) occupancy or daylight sensors available with Flush and Bottom Glow downlight diffusers. Refer to Occupancy Sensor, Daylight Sensor, and Enlighted Sensor tech sheets for more info.

FINISHES: Finelite Signal White (**SW**) powder coat, Finelite Black (RAL 9005) with semi gloss fine texture (**FB**)[9], and Satin Aluminum (**SA**)[9] are standard. Optional Adder: 185 RAL colors[9] are available.

LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.130 (G), this luminaire contains an internal driver disconnect. UL 924 and UL 2108 - PoE options available on request. These fixtures are rated for Damp Location. Chicago Plenum options available for C1, C2, or C3 suspension using our GridBox. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2015/863. Consult factory for tailored lighting options. Finelite makes the specification process easy when putting healthier products on your projects. Simply add – **RLA** (Red List Approved) or – **RLD** (Declared Label) to your part number.

WEIGHT[10]: ID - 3.4 lb/ft; D - 2.8 lb/ft; I - 2.8 lb/ft; AM - 2.9 lb/ft (luminaire only)

DLC QUALIFIED: Configurations of this product are listed on the DLC Qualified Products List (QPL). www.designlights.org/search

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

[7] Available in Indirect/Direct Regressed & Direct Regressed only
[8] Consult Finelite for Generator Transfer Device and Battery Backup fit
[9] 20 business days lead time for color
[10] Excludes Battery Back up and Generator Transfer Device weight

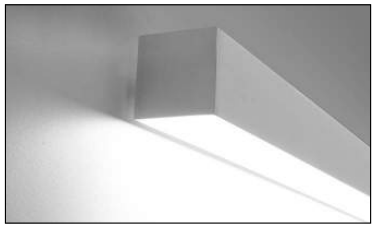
Submitted by:		Date:
Type:	Project:	
Ordering Info:		

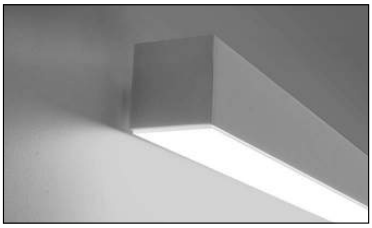
FINELITE®
Better Lighting

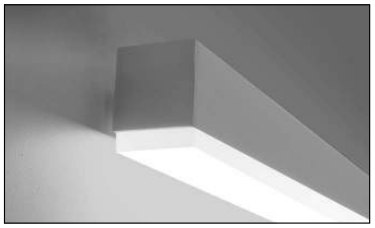
L20B

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

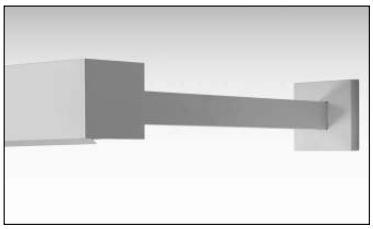
AESTHETIC OPTIONS


Flush Diffuser (**F**)

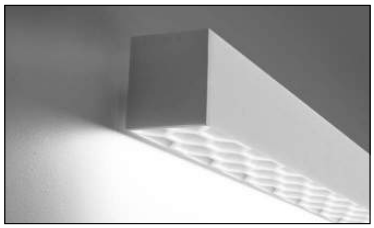

Bottom Glow Diffuser (**BG**)

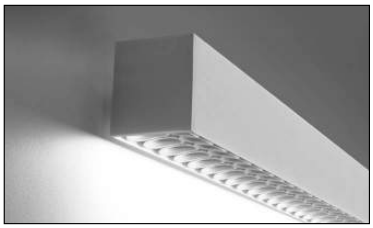

1" Drop Down Lens (**DL**)


Flat Diffuser with 1" Regressed (**RG-D**)


Kicker (**K**) - Wall Wash Arm Mount only


White Cross Blade Baffle[1] (**RG-WCB**)

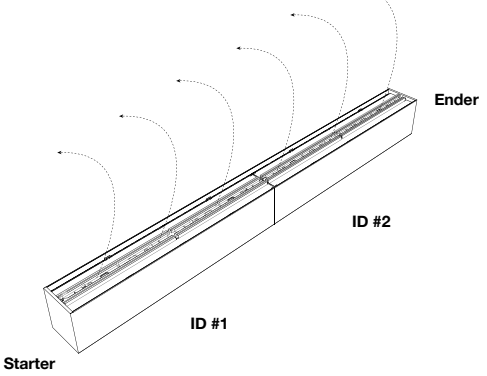

Hex Louver[1] (**RG-LHC**)


Hollowed Ellipse Louver[1] (**RG-LHE**)

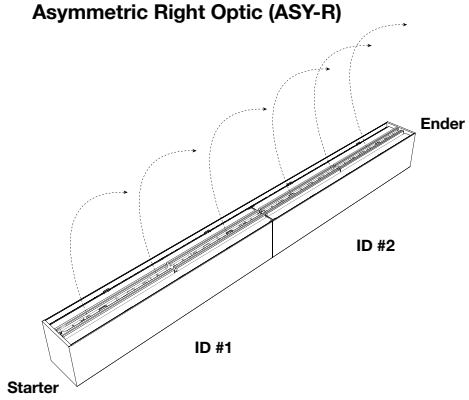
ASYMMETRIC OPTIONS

Use this tool to understand how to specify Asymmetric for your project. The diagrams below show a linear run from power feed to ender. Specify, ASY-L distributes light to the left or ASY-R distributed light to the right.

Asymmetric Left Optic (ASY-L)



Asymmetric Right Optic (ASY-R)



[1] Not available with Wall Wash

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

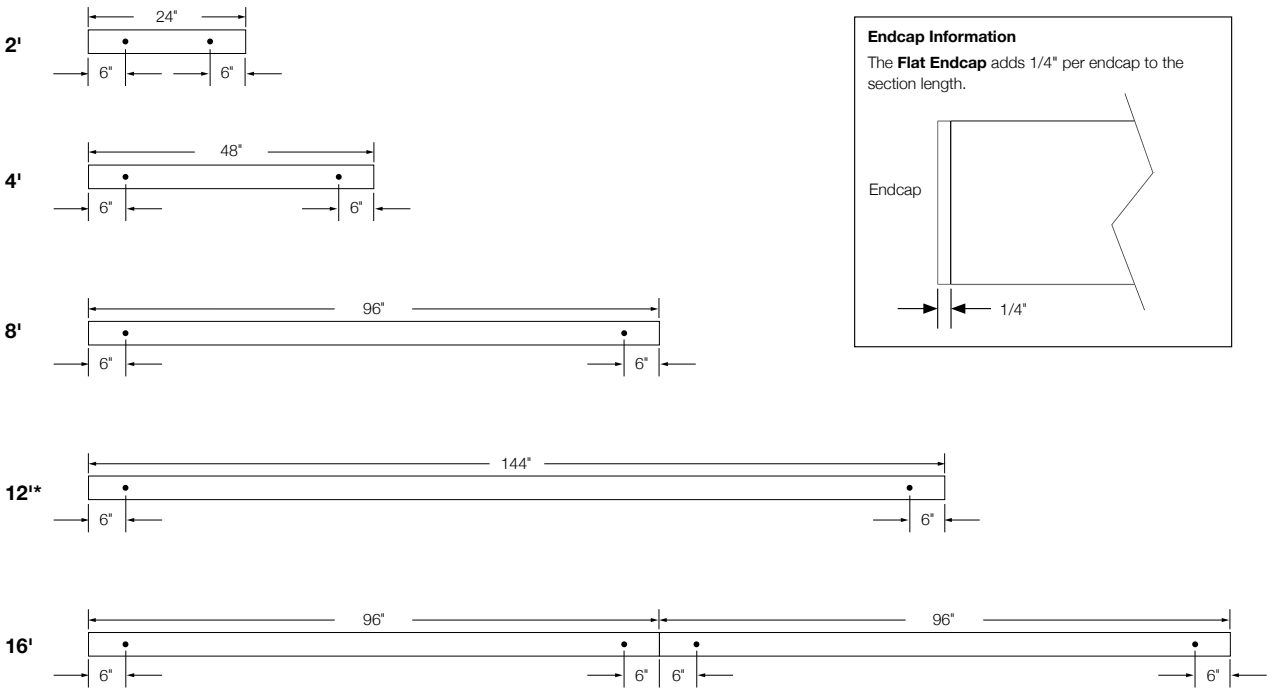
FINELITE®
Better Lighting

L20B

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

WALL WASH ARM MOUNT - Run Lengths & Mounting Location Examples

Tailored Lengths Available Down To 1/16" (±1/32")



Endcap Information

The **Flat Endcap** adds 1/4" per endcap to the section length.

• = Bracket Location
* = 12' Maximum spacing for two Arm Mount supports

Submitted by:		Date:
Type:	Project:	
Ordering Info:		

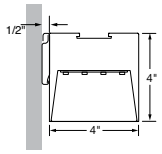
FINELITE® Better Lighting

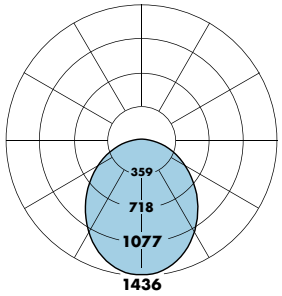
L20B

High Performance 4" Aperture (HP-4)
Wall Mount and Arm Mount

Direct Photometry - 4' Luminaire 3500K

HP4-WM-D-4'-V-835
Downlight: Flush Diffuser





CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0	FLUX
0	1436	1436	1436	1436	1436	
5	1428	1428	1427	1427	1427	135
15	1363	1353	1358	1357	1350	382
25	1236	1221	1226	1219	1212	563
35	1060	1047	1048	1037	1030	653
45	859	849	848	836	831	652
55	647	639	637	628	623	568
65	434	432	431	425	424	425
75	236	236	237	235	236	250
85	67	68	69	70	69	77
90	0	0	0	0	0	

Efficacy: 100 lm/W
Total luminaire output: 3705 lumens (926 lm/ft)
37 watts (9.3 W/ft)
Peak Candela Value: 1436 @ 0°
CRI: 80 / CCT: 3500K
ITL LM79 Report 85124

Complete LM79 LED Photometry

Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire			
S [1]	**B** [1]	**H** [1]	**V** [2]
1517	1907	2882	3705

Light Output, 3500K, 80 CRI (Lumens Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
379	477	720	926

Power, 3500K (Watts Per Foot)			
S [1]	**B** [1]	**H** [1]	**V** [2]
3.6	4.6	7.1	9.3

Efficacy, 3500K, 80 CRI (Lumens Per Watt)			
S [1]	**B** [1]	**H** [1]	**V** [2]
105	107	102	100

Sample Lumen Adjustment Calculation

Lumen Adjustment Factors 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

Lumen Adjustment Factors 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

High Output (**H**), 4000K, 90 CRI

Lumen Adjustment Factor: 0.789

Total Light Output: 2882 lm x 0.789 = 2274 lm

Total Light Output per Foot: 720 lm/ft x 0.789 = 568 lm/ft.

watts/foot: 7.1 W/ft.

$$\textbf{Efficacy} = \frac{568\ \frac{\text{lm}}{\text{ft.}}}{7.1\ \frac{\text{W}}{\text{ft.}}} = 80\ \text{lm/W}$$

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output

[1] Family Correlation based on 4' luminaire 3500K Very High Output (**V**) test - 120V.
[2] Based on ITL report: 85124

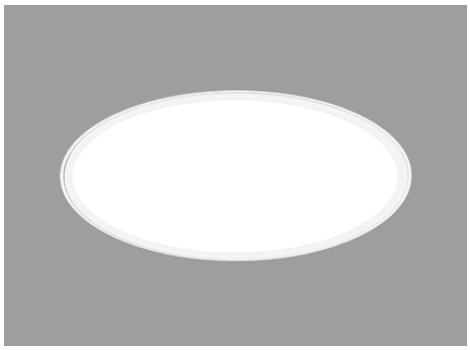
POP RECESSED

ROUND 48
STATIC WHITE

LUMENWERX

Project: _____

Type: L21A



Flush lens

DESCRIPTION

POP Recessed features a uniformly luminous diffuser that sits flush with the ceiling. The diffuser and light engine form a fully enclosed unit secured by a twist-and-lock mechanism for easy maintenance with no exposed hardware. POP Recessed delivers up to 112 LPW and installs in gypsum board ceilings.

5 YEAR WARRANTY

IC RATED

Up to 112 lm/W performance

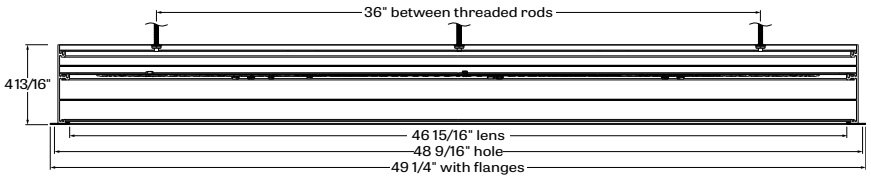
ORDER GUIDE

LUMINAIRE ID	SIZE	OPTICS	LENS	LIGHT SOURCE	CRI	LUMEN PACKAGES
POROR	48	ULO	FH			5000lm
POROR - Pop Round Recessed	**48** - 48" diameter	**ULO** - Uniform Lambertian Optic	**FH** - Flush	**SW** - Static white	**80** - 80CRI **90** - 90CRI (consult factory)	**7000** - Min. low output 7000lm **10000** - Medium output 10000lm **14000** - Max. high output 14000lm **####** - Other required lm

COLOR TEMP.	VOLTAGE	DRIVER [1]	ELECTRICAL	MOUNTING	FINISH	OPTIONS
				DF		
27 - 2700K **30** - 3000K **35** - 3500K **40** - 4000K	**120** - 120V **277** - 277V **UNV** - 120V-277V **347** - 347V	**D1** - 1% dimming 0-10V **DA** [2] - DALI **LTEA2W** - Lutron 1% - 2 wire FP 120V **LDE1** [2] - Lutron Hi-lume 1% Eco **LDE5** [2] - Lutron 5% EcoSystem **ELD1** - eldoLED 1% ECOdrive **ELD0** - eldoLED 0.1% SOLOdrive [1] PoE (Power-over-Ethernet) compatible. Consult factory for details. [2] On-site commissioning is required.	**1** - 1 circuit **+EB** - Emergency battery pack **+GTD** - Generator transfer device	**DF** - Drywall kit	**W** - Matte white	**FU** - Fuse **CP** - Chicago Plenum **NA** - None

Provide for EM light fixtures only

CROSS SECTION



POROR + FH - pop drop round recessed with flush lens

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Intertek

POPRECESSED48-ROUND-SPEC-REV1- March 15, 2021

PoE

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 199
H+B

POP RECESSED

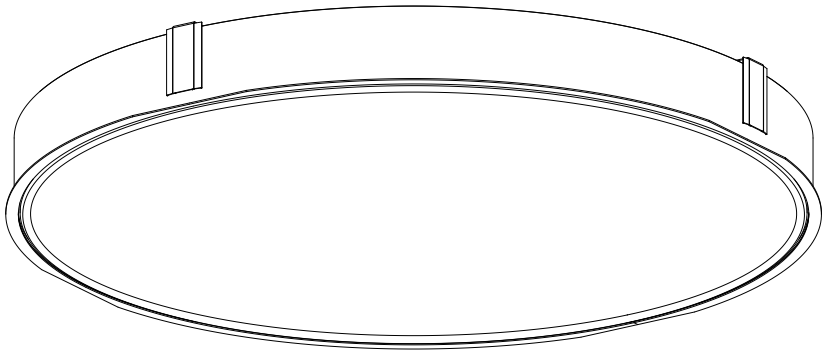
ROUND 48

STATIC WHITE

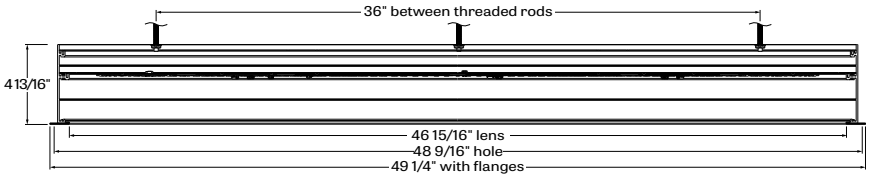
LUMENWERX

L21A

RECESSED FH - FLUSH



POROR - DF - drywall kit



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POP RECESSED

ROUND 48

STATIC WHITE

LUMENWERX

OPTICS

UNIFORM EFFICIENCY LAMBERTIAN OPTIC (ULO) - made of formed impact modified white PMMA, the optic provides an even light distribution with up to 88% transmission. Its unique enclosed shell design protects LEDs against Electrostatic Discharge and dust while its back surface project a soft glow on the mounting surface.

LIGHT SOURCE - STATIC WHITE

Custom array of mid-flux LEDs are mounted directly to the housing for optimal thermal performance. Available in 2700K, 3000K, 3500K and 4000K with a minimum 80 CRI and an option for 90 CRI with elevated R9 value. Color consistency maintained to within 3 SDCM. LEDs operated at reduced drive current to optimize efficacy and lumen maintenance.
All LEDs have been tested in accordance with IESNA LM-80-08 and the results have shown L80 lumen maintenance greater than 60,000 hours. Absolute product photometry is measured and presented in accordance with IESNA LM-79, unless otherwise indicated.

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
Low output	4000K	62.5	7000	112
Medium output	4000K	91.5	10000	109
High output	4000K	131	14000	107

ELECTRICAL

Factory-set, adjustable output current LED driver with universal (120-277VAC) input. Dimmable from 100% to 1% with 0-10V dimming control. Rated life (90% survivorship) of 50,000 hours at 50°C max. ambient (and 70°C max. case) temperature. At maximum driver load: Efficiency>84%, PF>0.9, THD<20%. Other specifiable options include Lutron Hi-Lume 1% (specify 2-wire, or Ecosystem Dim-to-Off), Lutron 5-Series (5% Ecosystem), eldoLED 1% ECOdrive, eldoLED 0.1% SOLOdrive, and DALI protocol drivers. All of our standard 0-10V drivers are NEMA 410 compliant.

PoE

Depending on the PoE manufacturer selected, Lumenwerx will install the node in factory as either integral to the luminaire or as a remote module. Factory programming of the PoE node may or may not enable the following functionalities: lumen package, Duo (tunable white), emergency battery backup, and sensor integration. These must be addressed and evaluated on a case-by-case basis.

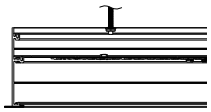
EMERGENCY

Factory installed long life high temperature recyclable Ni-Cad battery pack with test switch and charge indicator, minimum of 90 minutes operation, up to 1300 lumens (25°C) emergency lighting output. Recharge time of 24 hours.

MOUNTING OPTIONS

L21A

A separate kit for mounting fixtures into drywall ceilings.



DF - drywall kit

FINISH

Interior - 95% reflective, matte white powder coating
Exterior - matte white powder coating.

CONSTRUCTION

Housing - 16 gauge spun aluminum, matte white powder coating
Diffuser - Uniform Lambertian optic, thermoformed impact modified acrylic, completely enclosed

WEIGHT

RD 48 Flush - 53.58lbs - 24.33kg

CERTIFICATIONS

ETL - Rated for Indoor Dry/Damp locations. Conforms to UL Standard 1598 and certified to CAN/CSA Standard C22.2 No. 250.0.
Chicago plenum - City of Chicago Approved (CCEA)
IC rated - suitable for direct contact with insulation.

WARRANTY

Lumenwerx provides a five-year limited warranty of electrical and mechanical performance of the luminaires, including the LED boards, drivers, and auxiliary electronics. Lumenwerx will repair or replace defective luminaires or components at our discretion, provided they have been installed and operated in accordance with our specifications. Other limitations apply, please refer to the full warranty on our website.

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POPRECESSED48-ROUND-SPEC-REV1- March 15, 2021

POP RECESSED

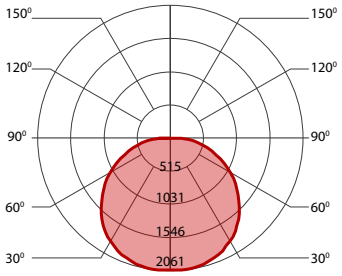
ROUND 48

STATIC WHITE

LUMENWERX

L21A

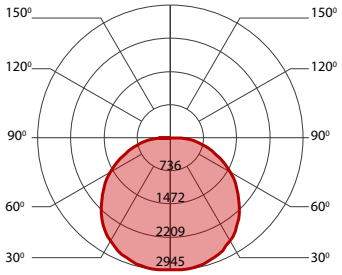
7000 LUMEN AT 80CRI - LOW OUTPUT



PERFORMANCE PER 4'

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
Low output	2700K	68	7000	103
Low output	3000K	66.5	7000	105
Low output	3500K	65	7000	108
Low output	4000K	62.5	7000	112

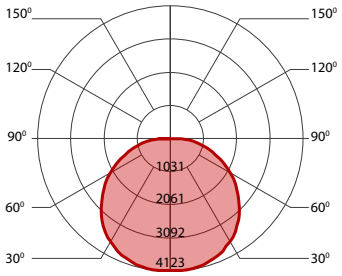
10000 LUMEN AT 80CRI - MEDIUM OUTPUT



PERFORMANCE PER 4'

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
Medium output	2700K	100	10000	100
Medium output	3000K	98	10000	102
Medium output	3500K	94.5	10000	106
Medium output	4000K	91.5	10000	109

14000 LUMEN AT 80CRI - HIGH OUTPUT



PERFORMANCE PER 4'

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
High output	2700K	143	14000	98
High output	3000K	140	14000	100
High output	3500K	134.5	14000	104
High output	4000K	131	14000	107

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Intertek

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Luminaire Product Data
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H+B

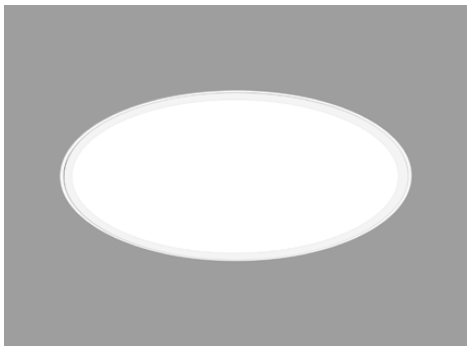
POP RECESSED

ROUND 48
STATIC WHITE

LUMENWERX

Project: _____

Type: L21B



Flush lens

DESCRIPTION

POP Recessed features a uniformly luminous diffuser that sits flush with the ceiling. The diffuser and light engine form a fully enclosed unit secured by a twist-and-lock mechanism for easy maintenance with no exposed hardware. POP Recessed delivers up to 112 LPW and installs in gypsum board ceilings.

5 YEAR WARRANTY

IC RATED

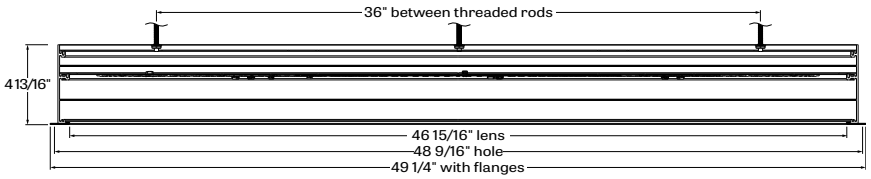
Up to 112 lm/W performance

ORDER GUIDE

LUMINAIRE ID	SIZE	OPTICS	LENS	LIGHT SOURCE	CRI	LUMEN PACKAGES
POROR	48	ULO	FH			3000lm
POROR - Pop Round Recessed	**48** - 48" diameter	**ULO** - Uniform Lambertian Optic	**FH** - Flush	**SW** - Static white	**80** - 80CRI **90** - 90CRI (consult factory)	**7000** - Min. low output 7000lm **10000** - Medium output 10000lm **14000** - Max. high output 14000lm **####** - Other required lm

COLOR TEMP.	VOLTAGE	DRIVER [1]	ELECTRICAL	MOUNTING	FINISH	OPTIONS
				DF		
27 - 2700K **30** - 3000K **35** - 3500K **40** - 4000K	**120** - 120V **277** - 277V **UNV** - 120V-277V **347** - 347V	**D1** - 1% dimming 0-10V **DA** [2] - DALI **LTEA2W** - Lutron 1% - 2 wire FP 120V **LDE1** [2] - Lutron Hi-lume 1% Eco **LDE5** [2] - Lutron 5% EcoSystem **ELD1** - eldoLED 1% ECOdrive **ELD0** - eldoLED 0.1% SOLOdrive [1] PoE (Power-over-Ethernet) compatible. Consult factory for details. [2] On-site commissioning is required.	**1** - 1 circuit **+EB** - Emergency battery pack **+GTD** - Generator transfer device	**DF** - Drywall kit	**W** - Matte white	**FU** - Fuse **CP** - Chicago Plenum **NA** - None

CROSS SECTION



POROR + FH - pop drop round recessed with flush lens

3737 Cote Vertu St-Laurent, Quebec, Canada H4R 2C9
T (514) 225-4304 F (514) 931 -4862
www.lumenwerx.com

Intertek

POPRECESSED48-ROUND-SPEC-REV1- March 15, 2021

PoE

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 203
H+B

POP RECESSED

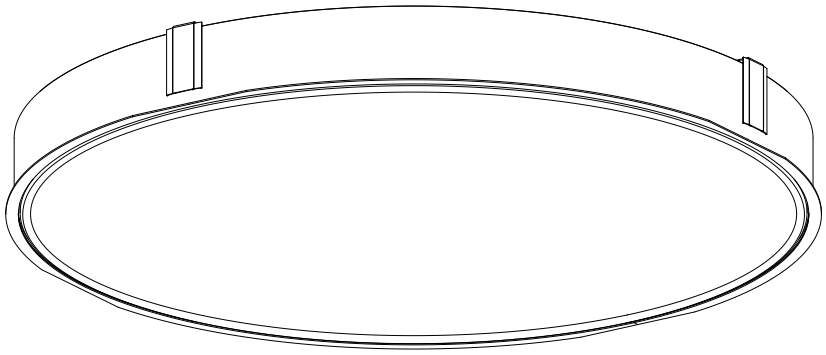
ROUND 48

STATIC WHITE

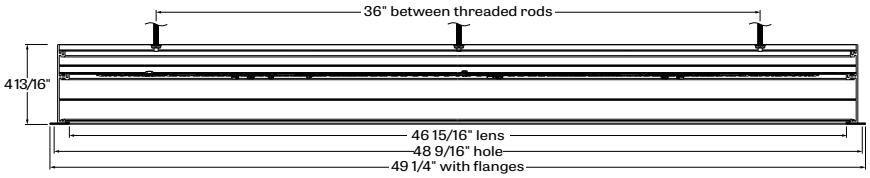
LUMENWERX

L21B

RECESSED FH - FLUSH



POROR - DF - drywall kit



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POPRECESSED48-ROUND-SPEC-REV1- March 15, 2021

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POP RECESSED

ROUND 48

STATIC WHITE

LUMENWERX

OPTICS

UNIFORM EFFICIENCY LAMBERTIAN OPTIC (ULO) - made of formed impact modified white PMMA, the optic provides an even light distribution with up to 88% transmission. Its unique enclosed shell design protects LEDs against Electrostatic Discharge and dust while its back surface project a soft glow on the mounting surface.

LIGHT SOURCE - STATIC WHITE

Custom array of mid-flux LEDs are mounted directly to the housing for optimal thermal performance. Available in 2700K, 3000K, 3500K and 4000K with a minimum 80 CRI and an option for 90 CRI with elevated R9 value. Color consistency maintained to within 3 SDCM. LEDs operated at reduced drive current to optimize efficacy and lumen maintenance.
All LEDs have been tested in accordance with IESNA LM-80-08 and the results have shown L80 lumen maintenance greater than 60,000 hours. Absolute product photometry is measured and presented in accordance with IESNA LM-79, unless otherwise indicated.

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
Low output	4000K	62.5	7000	112
Medium output	4000K	91.5	10000	109
High output	4000K	131	14000	107

ELECTRICAL

Factory-set, adjustable output current LED driver with universal (120-277VAC) input. Dimmable from 100% to 1% with 0-10V dimming control. Rated life (90% survivorship) of 50,000 hours at 50°C max. ambient (and 70°C max. case) temperature. At maximum driver load: Efficiency>84%, PF>0.9, THD<20%. Other specifiable options include Lutron Hi-Lume 1% (specify 2-wire, or Ecosystem Dim-to-Off), Lutron 5-Series (5% Ecosystem), eldoLED 1% ECOdrive, eldoLED 0.1% SOLOdrive, and DALI protocol drivers. All of our standard 0-10V drivers are NEMA 410 compliant.

PoE

Depending on the PoE manufacturer selected, Lumenwerx will install the node in factory as either integral to the luminaire or as a remote module. Factory programming of the PoE node may or may not enable the following functionalities: lumen package, Duo (tunable white), emergency battery backup, and sensor integration. These must be addressed and evaluated on a case-by-case basis.

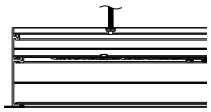
EMERGENCY

Factory installed long life high temperature recyclable Ni-Cad battery pack with test switch and charge indicator, minimum of 90 minutes operation, up to 1300 lumens (25°C) emergency lighting output. Recharge time of 24 hours.

MOUNTING OPTIONS

L21B

A separate kit for mounting fixtures into drywall ceilings.



DF - drywall kit

FINISH

Interior - 95% reflective, matte white powder coating
Exterior - matte white powder coating.

CONSTRUCTION

Housing - 16 gauge spun aluminum, matte white powder coating
Diffuser - Uniform Lambertian optic, thermoformed impact modified acrylic, completely enclosed

WEIGHT

RD 48 Flush - 53.58lbs - 24.33kg

CERTIFICATIONS

ETL - Rated for Indoor Dry/Damp locations. Conforms to UL Standard 1598 and certified to CAN/CSA Standard C22.2 No. 250.0.
Chicago plenum - City of Chicago Approved (CCEA)
IC rated - suitable for direct contact with insulation.

WARRANTY

Lumenwerx provides a five-year limited warranty of electrical and mechanical performance of the luminaires, including the LED boards, drivers, and auxiliary electronics. Lumenwerx will repair or replace defective luminaires or components at our discretion, provided they have been installed and operated in accordance with our specifications. Other limitations apply, please refer to the full warranty on our website.

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POPRECESSED48-ROUND-SPEC-REV1- March 15, 2021

POP RECESSED

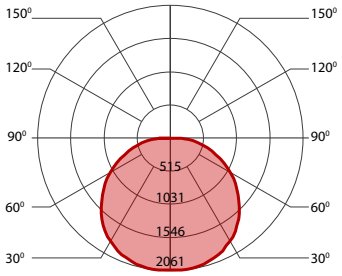
ROUND 48

STATIC WHITE

LUMENWERX

L21B

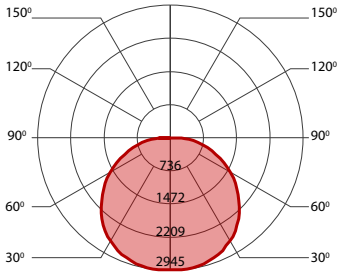
7000 LUMEN AT 80CRI - LOW OUTPUT



PERFORMANCE PER 4'

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
Low output	2700K	68	7000	103
Low output	3000K	66.5	7000	105
Low output	3500K	65	7000	108
Low output	4000K	62.5	7000	112

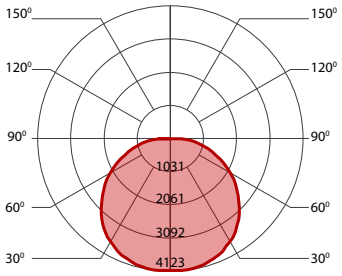
10000 LUMEN AT 80CRI - MEDIUM OUTPUT



PERFORMANCE PER 4'

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
Medium output	2700K	100	10000	100
Medium output	3000K	98	10000	102
Medium output	3500K	94.5	10000	106
Medium output	4000K	91.5	10000	109

14000 LUMEN AT 80CRI - HIGH OUTPUT



PERFORMANCE PER 4'

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
High output	2700K	143	14000	98
High output	3000K	140	14000	100
High output	3500K	134.5	14000	104
High output	4000K	131	14000	107

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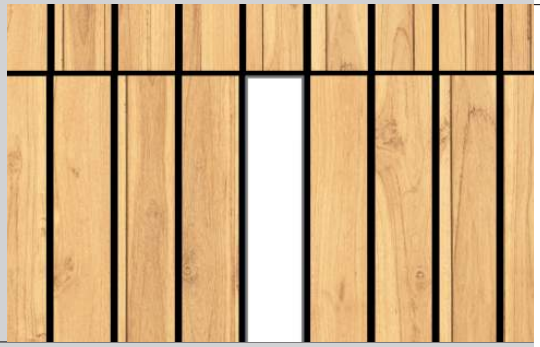
Intertek

POPRECESSED48-ROUND-SPEC-REV1- March 15, 2021

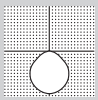
PoE

PANO 5.25"
WOODWORKS®
Linear Solid & Veneered Wood Panels

L22

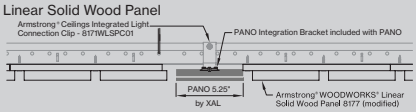


PERFORMANCE
- Coordinates with Woodworks® Linear & Veneered ceiling panel
- Up to 128lm/W
- High performance opal cover
- Remote mountable LED driver

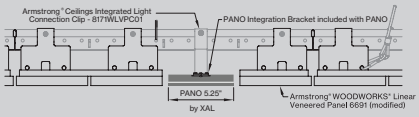


WoodWorks® Grille Ceiling Integration

Linear Solid Wood Panel



Linear Solid Wood Panel



REMOTE MOUNTING
Quick and easy electrical connection

link to page

REMOTE MOUNTING

ARMSTRONG CEILING TYPES
WARM, AESTHETIC ROOMS

WT5 - WOODWORKS® GRILLE TEGULAR 15/16

WT5 - WOODWORKS® GRILLE TEGULAR VERTICAL SLATS

WLS - WOODWORKS® GRILLE SOLID WOOD PANELS

WLV - WOODWORKS® GRILLE VENEERED PANELS

Physical attributes

A RANGE

PANO 5.25"	P A N O 5

B CEILING TYPE

WoodWorks® linear solid wood panels	W L S
WoodWorks® linear veneered panels	W L V

please contact your Armstrong® ceilings rep for the Integrated Light Connection Clip for the specified ceiling type

C COLOR

White	W H
Black	B L

D POSITION

Single	S N

E POWER FEED LENGTH

4' standard integrated	P S
10' medium remote option	P M
30' long remote option	P L

power feed distance denotes secondary wiring from detachable driver box to fixture; driver box comes with a 6 ft conduit for primary wiring

F LENS

HP opal cover	O P

G CCT

2700 K	2 7 K
3000 K	3 0 K
3500 K	3 5 K
4000 K	4 0 K
Custom CCT	X X K

H CRI

CRI > 80	C 8 0
CRI > 90	C 9 0

Electrical attributes

I VOLTAGE

120V / 277V	U N V

J DIMMING

0-10V 1%	0 1 0 V
DALI	D A L I
Lutron EcoSystem Quantum, Vive, GRAFIK Eye, HomeWorks	L E S 1
Power over ethernet	P O E C

consult customer service for compatibility

Custom dimming	X X X X

consult customer service for compatibility

K SENSOR (optional)

Integrated Sensor	S E N

consult customer service for sensor request

L OUTPUT LM/FT DIRECT

550 lm/ft 100% ↧	0 5 5 0 L F
775 lm/ft 100% ↧	0 7 7 5 L F
1000 lm/ft 100% ↧	1 0 0 0 L F

M CIRCUIT / EM

Single circuit	*

leave blank

Dimensional attributes

N SHAPE / PATTERN

Linear / straight	S T

O DIMENSIONS IN FT

8' fixture	0 8 F T

fixture replaces full length of ceiling panel, please see table on next page and fixture length dimensions

35FT TOTAL RUN LENGTH

CS-V01 08/2021

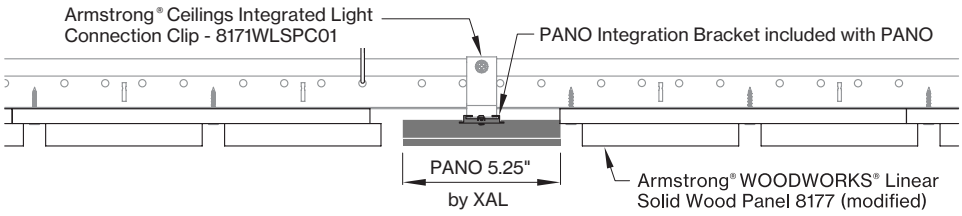
Technical data

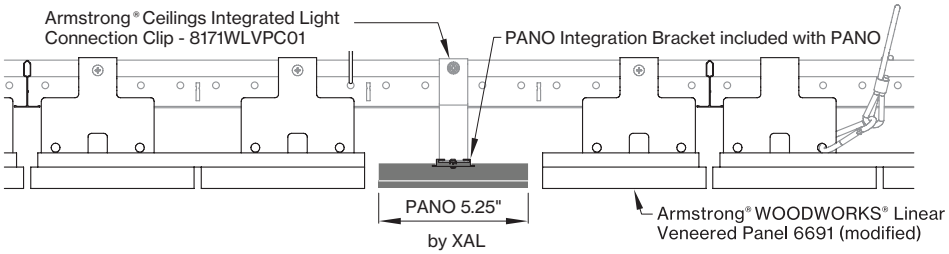
	SIZE TYPE	LED COLOR TEMPERATURE	INPUT WATTS	POWER CONSUMPTION	DELIVERED LM TOTAL	LIGHT DISTRIBUTION	DELIVERED LUMEN DIRECT	OPTICAL EFFICIENCY	LUMINAIRE EFFICACY
PANO 5.25"									
e LED	8' opal	40 K	41.4 W	5.1 W/ft	4400 lm	100 % down	4400 lm	69 %	110 lm/W
e² LED	8' opal	40 K	60 W	7.5 W/ft	6200 lm	100 % down	6200 lm	69 %	106 lm/W
e²⁺ LED	8' opal	40 K	81.6 W	10.2 W/ft	8000 lm	100 % down	8000 lm	69 %	98 lm/W

for 27 K, 30 K or 35 K multiply lm value by 0.96

WoodWorks® Grille Ceiling System Integration

(for more ceiling options, please see CEILING OPTIONS pages)





WoodWorks® ceiling systems

XAL PANO is only approved for Armstrong® WoodWorks Grille Tegular 9/16, WoodWorks Grille Tegular 15/16, WoodWorks Grille, WoodWorks Linear Solid Wood panels and WoodWorks Linear Veneered panels ceiling systems.
Refer to armstrongceilings.com for installation instructions related to the ceiling products.

Available lengths for ceiling types

CEILING TYPE	2 FT	4 FT	8 FT
WoodWorks® Grille Tegular 9/16	23.375"	47.375"	n/a
WoodWorks® Grille Tegular 15/16	23"	47"	n/a
WoodWorks® Grille	n/a	n/a	95"
WoodWorks® Linear Solid Wood panels	n/a	n/a	95"
WoodWorks® Linear Veneered panels	n/a	n/a	95.25"

please contact your Armstrong® Ceilings rep for the Integrated Light Connection Clip for the specified ceiling type

INTEGRATED LIGHT CONNECTION CLIP

Armstrong® Ceilings Integrated Light Connection Clip — visit armstrongceilings.com/linearlighting

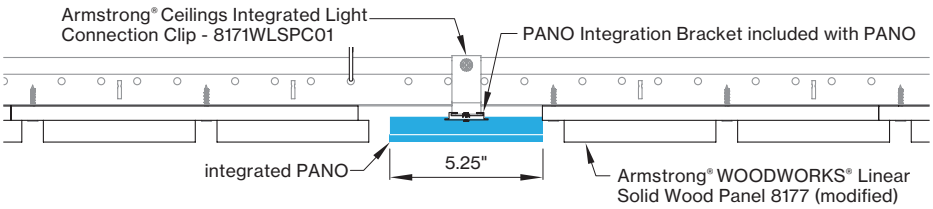
please contact your Armstrong Ceilings rep

CS-V01 08/2021

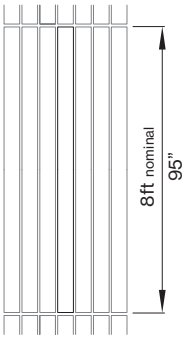
DIMENSIONS

L22

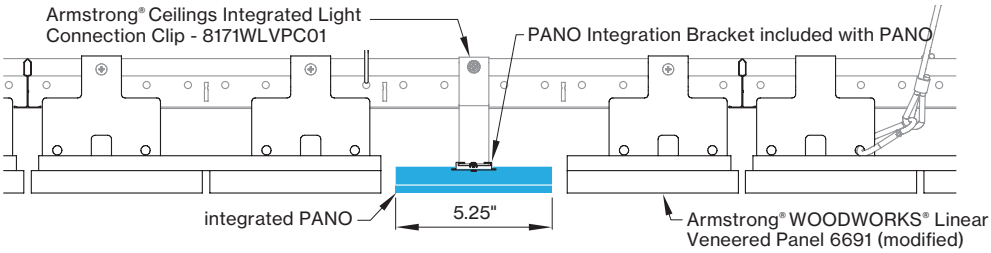
WLS - ARMSTRONG® WOODWORKS® LINEAR SOLID WOOD PANELS



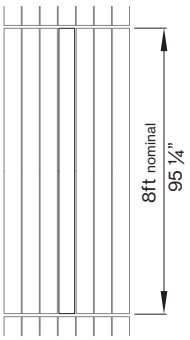
WLS view from below



WLV - ARMSTRONG® WOODWORKS® LINEAR VENEERED PANELS



WLV view from below



PANO mounting instructions

Get access to the PANO mounting instructions faster by scanning the QR code.

https://www.xalusa.com/resources/cut-sheets/pano

CS-V01 08/2021

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	OA

APPLICATION GUIDE: STANDARD SPECIAL SIGNAGE

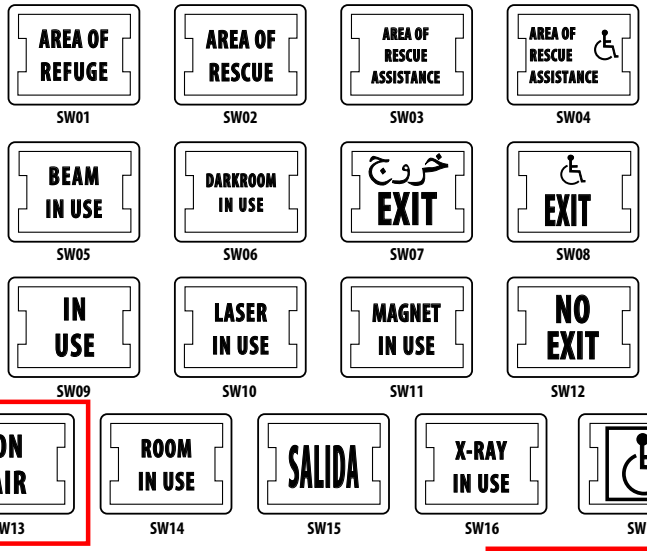
Lithonia Lighting offers special signage signs to suit many applications. The Signature and Quantum families highlighted below are illuminated with energy-efficient, long-life Light Emitting Diodes (LEDs).

WARRANTY — Complete warranty terms located at:
www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application.
Specifications subject to change without notice.

LE P
Signature

LQM P
Quantum



ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

As indicated on plan

Example: LE P 1 R EL N SW02

Family		Face type		Housing color		Number of faces		Letter color		Input voltage		Operation	
LE	Signature die-cast aluminum sign[1]	P	Panel	(blank)	Matte black, brushed aluminum face	1	Single face	R	Red	(blank)	120 thru 277V, 50/60hz (only required with LE series)[1]	(blank)	AC only
LQM	Quantum thermoplastic sign[2,3,4]			W	White	2	Double face	G	Green	120/277	Dual voltage[3,5]	EL N	Nickel-cadmium battery
						3	Single face with extra faceplate and color panel[4]						

Special wording							
SW01	AREA OF REFUGE[6]	SW05	BEAM IN USE[6,7]	SW09	IN USE[6,7]	SW13	ON AIR[6,7]
SW02	AREA OF RESCUE[6]	SW06	DARK ROOM IN USE[6,7]	SW10	LASER IN USE[6,7]	SW14	ROOM IN USE[6,7]
SW03	AREA OF RESCUE ASSISTANCE[6]	SW07	EXIT Arabic/English[8,9]	SW11	MAGNET IN USE[6,7]	SW15	SALIDA[9]
SW04	AREA OF RESCUE ASSISTANCE with access pictogram[6]	SW08	EXIT with access pictogram[9]	SW12	NO EXIT[9]	SW16	X-RAY IN USE[6,7]
						SW17	Handicap Symbol[6]

Notes

1. See spec sheet LE-LRE for complete specifications
2. Only available in white housing. EL N operation only available in red letters for LQM family.
3. See spec sheet LQM for complete specifications
4. Must be ordered with LQM series. Not available with single (1) or double (2) face in description.
5. Only required when ordering LQM family (ex: LQM P W 3 R 120/277 SW01).
6. UL48 listing as an electric sign only.
7. Not available with EL N operation.
8. Only available in red letters.
9. Not available with UL924 listing.

CUSTOM SIGNAGE

MAINTENANCE

All life safety equipment, including emergency lighting for path of egress must be maintained, serviced, and tested in accordance with all National Fire Protection Association (NFPA) and local codes. Failure to perform the required maintenance, service, or testing could jeopardize the safety of occupants and will void all warranties.

EMERGENCY: One Lithonia Way, Conyers, GA 30012 Phone: 800-334-8694 techsupport-emergency@acuitybrands.com www.lithonia.com

D-Series Size 0
LED Area Luminaire

Buy American

Catalog Number

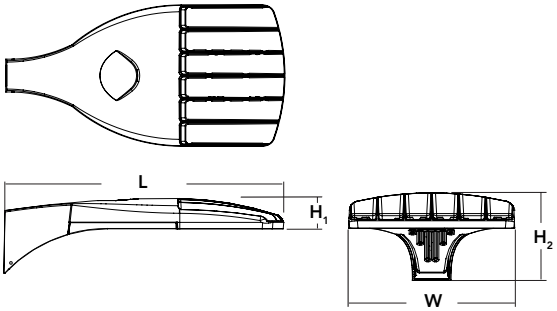
Notes

Type S1

Hit the Tab key or mouse over the page to see all interactive elements.

Specifications

EPA:	0.95 ft² (.09 m²)
Length:	26" (66.0 cm)
Width:	13" (33.0 cm)
Height$_1$:	3" (7.62 cm)
Height$_2$:	7" (17.8 cm)
Weight (max):	16 lbs (7.25 kg)



Introduction

The modern styling of the D-Series is striking yet unobtrusive - making a bold, progressive statement even as it blends seamlessly with its environment. The D-Series distills the benefits of the latest in LED technology into a high performance, high efficacy, long-life luminaire.

The outstanding photometric performance results in sites with excellent uniformity, greater pole spacing and lower power density. It is ideal for replacing up to 400W metal halide with typical energy savings of 70% and expected service life of over 100,000 hours.

Ordering Information

EXAMPLE: DSX0 LED P6 40K T3M MVOLT SPA NLTAIR2 PIRHN DDBXD

DSX0 LED

Series	LEDs	Color temperature	Distribution	Voltage	Mounting
DSX0 LED	**Forward optics** P1 P5 P2 P6 P3 P7[1] P4[1] **Rotated optics** P10[2] P12[2] P11[2] P13[1,2]	30K 3000 K 40K 4000 K 50K 5000 K	T1S Type I short (Automotive) T2S Type II short T2M Type II medium T3S Type III short T3M Type III medium T4M Type IV medium TFTM Forward throw medium T5VS Type V very short[3] T5S Type V short[3] T5M Type V medium[3] T5W Type V wide[3] BLC Backlight control[4] LCCO Left corner cutoff[4] RCCO Right corner cutoff[4]	MVOLT (120V-277V)[5,6] XVOLT (277V-480V)[7,8,9] 120[6] 208[6] 240[6] 277[6] 347[6] 480[6]	**Shipped included** SPA Square pole mounting RPA Round pole mounting[10] WBA Wall bracket[3] SPUMBA Square pole universal mounting adaptor[11] RPUMBA Round pole universal mounting adaptor[11] **Shipped separately** KMA8 DDBXD U Mast arm mounting bracket adaptor (specify finish)[12]

Control options		Other options	Finish *(required)*
Shipped installed NLTAIR2 nLight AIR generation 2 enabled[13,14] PIRHN Network, high/low motion/ambient sensor[15] PER NEMA twist-lock receptacle only (control ordered separate)[16] PER5 Five-pin receptacle only (control ordered separate)[16,17] PER7 Seven-pin receptacle only (leads exit fixture) (control ordered separate)[16,17] DMG 0-10V dimming extend out back of housing for external control (control ordered separate)[18]	PIR High/low, motion/ambient sensor, 8–15' mounting height, ambient sensor enabled at 5fc[19,20] PIRH High/low, motion/ambient sensor, 15–30' mounting height, ambient sensor enabled at 5fc[19,20] PIR1FC3V High/low, motion/ambient sensor, 8–15' mounting height, ambient sensor enabled at 1fc[19,20] PIRH1FC3V High/low, motion/ambient sensor, 15–30' mounting height, ambient sensor enabled at 1fc[19,20] FAO Field adjustable output[21]	**Shipped installed** HS House-side shield[22] SF Single fuse (120, 277, 347V)[6] DF Double fuse (208, 240, 480V)[6] L90 Left rotated optics[2] R90 Right rotated optics[2] DDL Diffused drop lens[22] HA 50°C ambient operations[1] BAA Buy America(n) Act Compliant **Shipped separately** BS Bird spikes[23] EGS External glare shield	DDBXD Dark bronze DBLXD Black DNAXD Natural aluminum DWHXD White DDBTXD Textured dark bronze DBLBXD Textured black DNATXD Textured natural aluminum DWHGXD Textured white

18-719
12/07/21
Bids

Luminaire Product Data
26 5700 - 212
H+B

Ordering Information

S1

Accessories

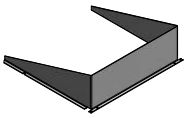
Ordered and shipped separately.

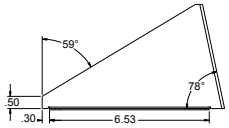
DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V) [24]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V) [24]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V) [24]
DSHORT SBK U	Shorting cap [24]
DSX0HS 20C U	House-side shield for P1,P2,P3 and P4 [22]
DSX0HS 30C U	House-side shield for P10,P11,P12 and P13 [22]
DSX0HS 40C U	House-side shield for P5,P6 and P7 [22]
DSX0DDL U	Diffused drop lens (polycarbonate) [22]
PUMBA DDBXD U*	Square and round pole universal mounting bracket adaptor (specify finish) [25]
KMA8 DDBXD U	Mast arm mounting bracket adaptor (specify finish) [12]
DSX0EGS (FINISH) U	External glare shield

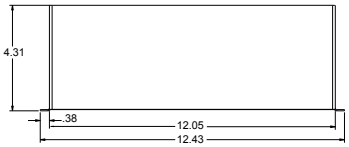
For more control options, visit DTL and ROAM online. Link to nLight Air 2

NOTES
1 HA not available with P4, P7, and P13.
2 P10, P11, P12 and P13 and rotated options (L90 or R90) only available together.
3 Any Type 5 distribution with photocell, is not available with WBA.
4 Not available with HS or DDL.
5 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
6 Single fuse (SF) requires 120V, 277V or 347V. Double fuse (DF) requires 208V, 240V or 480V. XVOLT not available with fusing (SF or DF).
7 XVOLT only suitable for use with P4, P7 and P13.
8 XVOLT operates with any voltage between 277V and 480V.
9 XVOLT not available with fusing (SF or DF) and not available with PIR, PIRH, PIR1FC3V, PIRH1FC3V.
10 Suitable for mounting to round poles between 3.5" and 12" diameter.
11 Universal mounting brackets intended for retrofit on existing pre-drilled poles only. 1.5 G vibration load rating per ANCI C136.31. Only usable when pole's drill pattern is NOT Lithonia template #8.
12 Must order fixture with SPA mounting. Must be ordered as a separate accessory; see Accessories information. For use with 2-3/8" diameter mast arm (not included).
13 Must be ordered with PIRHN.
14 Sensor cover available only in dark bronze, black, white and natural aluminum colors.
15 Must be ordered with NLTAIR2. For more information on nLight Air 2 visit this link
16 Photocell ordered and shipped as a separate line item from Acuity Brands Controls. See accessories. Shorting Cap included.
17 If ROAM® node required, it must be ordered and shipped as a separate line item from Acuity Brands Controls. Shorting Cap included.
18 DMG not available with PIRHN, PER5, PER7, PIR, PIRH, PIR1FC3V or PIRH1FC3V, FAO.
19 Reference Controls Options table on page 4.
20 Reference Motion Sensor Default Table on page 4 to see functionality.
21 Not available with other dimming controls options.
22 Not available with BLC, LCCO and RCCO distribution.
23 Must be ordered with fixture for factory pre-drilling.
24 Requires luminaire to be specified with PER, PER5 or PER7 option. See Controls Table on page 4.
25 For retrofit use only. Only usable when pole's drill pattern is NOT Lithonia template #8

EGS – External Glare Shield

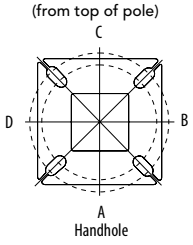


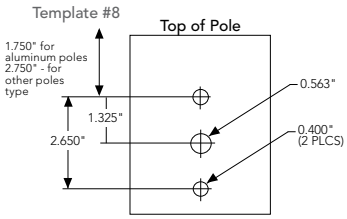




Drilling

HANDHOLE ORIENTATION
(from top of pole)





Tenon Mounting Slipfitter

Tenon O.D.	Mounting	Single Unit	2 @ 180	2 @ 90	3 @ 90	3 @120	4 @ 90
2-3/8"	RPA	AS3-5 190	AS3-5 280	AS3-5 290	AS3-5 390	AS3-5 320	AS3-5 490
2-7/8"	RPA	AST25-190	AST25-280	AST25-290	AST25-390	AST25-320	AST25-490
4"	RPA	AST35-190	AST35-280	AST35-290	AST35-390	AST35-320	AST35-490

Mounting Option	Drilling Template	Single	2 @ 180	2 @ 90	3 @ 90	3 @ 120	4 @ 90
Head Location		Side B	Side B & D	Side B & C	Side B, C & D	Round Pole Only	Side A, B, C & D
Drill Nomenclature	#8	DM19AS	DM28AS	DM29AS	DM39AS	DM32AS	DM49AS
		Minimum Acceptable Outside Pole Dimension					
SPA	#8	2-7/8"	2-7/8"	3.5"	3.5"		3.5"
RPA	#8	2-7/8"	2-7/8"	3.5"	3.5"	3"	3.5"
SPUMBA	#5	2-7/8"	3"	4"	4"		4"
RPUMBA	#5	2-7/8"	3.5"	5"	5"	3.5"	5"

DSX0 Area Luminaire - EPA

*Includes luminaire and integral mounting arm. Other tenons, arms, brackets or other accessories are not included in this EPA data.

Fixture Quantity & Mounting Configuration	Single DM19	2 @ 180 DM28	2 @ 90 DM29	3 @ 90 DM39	3 @ 120 DM32	4 @ 90 DM49
Mounting Type						
DSX0 LED	0.950	1.900	1.830	2.850	2.850	3.544

Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Area Size 0 homepage.

Isofootcandle plots for the DSX0 LED 40C 1000 40K. Distances are in units of mounting height (20').

S1

LEGEND
0.1 fc
0.5 fc
1.0 fc

Performance Data

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.04
5°C	41°F	1.04
10°C	50°F	1.03
15°C	50°F	1.02
20°C	68°F	1.01
25°C	**77°C**	**1.00**
30°C	86°F	0.99
35°C	95°F	0.98
40°C	104°F	0.97

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the platforms noted in a **25°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	Lumen Maintenance Factor
25,000	0.96
50,000	0.92
100,000	0.85

Motion Sensor Default Settings						
Option	Dimmed State	High Level (when triggered)	Photocell Operation	Dwell Time	Ramp-up Time	Ramp-down Time
PIR or PIRH	3V (37%) Output	10V (100%) Output	Enabled @ 5FC	5 min	3 sec	5 min
*PIR1FC3V or PIRH1FC3V	3V (37%) Output	10V (100%) Output	Enabled @ 1FC	5 min	3 sec	5 min
*for use when motion sensor is used as dusk to dawn control.						

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Electrical Load

					Current (A)					
	Performance Package	LED Count	Drive Current	Wattage	120	208	240	277	347	480
Forward Optics (Non-Rotated)	P1	20	530	38	0.32	0.18	0.15	0.15	0.10	0.08
	P2	20	700	49	0.41	0.23	0.20	0.19	0.14	0.11
	P3	20	1050	71	0.60	0.37	0.32	0.27	0.21	0.15
	P4	20	1400	92	0.77	0.45	0.39	0.35	0.28	0.20
	P5	40	700	89	0.74	0.43	0.38	0.34	0.26	0.20
	P6	40	1050	134	1.13	0.65	0.55	0.48	0.39	0.29
	P7	40	1300	166	1.38	0.80	0.69	0.60	0.50	0.37
Rotated Optics (Requires L90 or R90)	P10	30	530	53	0.45	0.26	0.23	0.21	0.16	0.12
	P11	30	700	72	0.60	0.35	0.30	0.27	0.20	0.16
	P12	30	1050	104	0.88	0.50	0.44	0.39	0.31	0.23
	P13	30	1300	128	1.08	0.62	0.54	0.48	0.37	0.27

Controls Options

Nomenclature	Description	Functionality	Primary control device	Notes
FAO	Field adjustable output device installed inside the luminaire; wired to the driver dimming leads.	Allows the luminaire to be manually dimmed, effectively trimming the light output.	FAO device	Cannot be used with other controls options that need the 0-10V leads
DS	Drivers wired independently for 50/50 luminaire operation	The luminaire is wired to two separate circuits, allowing for 50/50 operation.	Independently wired drivers	Requires two separately switched circuits. Consider nLight AIR as a more cost effective alternative.
PER5 or PER7	Twist-lock photocell receptacle	Compatible with standard twist-lock photocells for dusk to dawn operation, or advanced control nodes that provide 0-10V dimming signals.	Twist-lock photocells such as DLL Elite or advanced control nodes such as ROAM.	Pins 4 & 5 to dimming leads on driver, Pins 6 & 7 are capped inside luminaire
PIR or PIRH	Motion sensors with integral photocell. PIR for 8-15' mounting; PIRH for 15-30' mounting	Luminaires dim when no occupancy is detected.	Acuity Controls SBGR	Also available with PIRH1FC3V when the sensor photocell is used for dusk-to-dawn operation.
NLTAIR2 PIRHN	nLight AIR enabled luminaire for motion sensing, photocell and wireless communication.	Motion and ambient light sensing with group response. Scheduled dimming with motion sensor over-ride when wirelessly connected to the nLight Eclypse.	nLight Air rSDGR	nLight AIR sensors can be programmed and commissioned from the ground using the CIAIRity Pro app.

Performance Data

S1

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

Forward Optics

Power Package	LED Count	Drive Current	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P1	20	530	38W	T1S	4,369	1	0	1	115	4,706	1	0	1	124	4,766	1	0	1	125
				T2S	4,364	1	0	1	115	4,701	1	0	1	124	4,761	1	0	1	125
				T2M	4,387	1	0	1	115	4,726	1	0	1	124	4,785	1	0	1	126
				T3S	4,248	1	0	1	112	4,577	1	0	1	120	4,634	1	0	1	122
				T3M	4,376	1	0	1	115	4,714	1	0	1	124	4,774	1	0	1	126
				T4M	4,281	1	0	1	113	4,612	1	0	2	121	4,670	1	0	2	123
				TFTM	4,373	1	0	1	115	4,711	1	0	2	124	4,771	1	0	2	126
				T5VS	4,548	2	0	0	120	4,900	2	0	0	129	4,962	2	0	0	131
				T5S	4,552	2	0	0	120	4,904	2	0	0	129	4,966	2	0	0	131
				T5M	4,541	3	0	1	120	4,891	3	0	1	129	4,953	3	0	1	130
				T5W	4,576	3	0	2	120	4,929	3	0	2	130	4,992	3	0	2	131
				BLC	3,586	1	0	1	94	3,863	1	0	1	102	3,912	1	0	1	103
				LCCO	2,668	1	0	1	70	2,874	1	0	2	76	2,911	1	0	2	77
				RCCO	2,668	1	0	1	70	2,874	1	0	2	76	2,911	1	0	2	77
P2	20	700	49W	T1S	5,570	1	0	1	114	6,001	1	0	1	122	6,077	2	0	2	124
				T2S	5,564	1	0	2	114	5,994	1	0	2	122	6,070	2	0	2	124
				T2M	5,593	1	0	1	114	6,025	1	0	1	123	6,102	1	0	1	125
				T3S	5,417	1	0	2	111	5,835	1	0	2	119	5,909	2	0	2	121
				T3M	5,580	1	0	2	114	6,011	1	0	2	123	6,087	1	0	2	124
				T4M	5,458	1	0	2	111	5,880	1	0	2	120	5,955	1	0	2	122
				TFTM	5,576	1	0	2	114	6,007	1	0	2	123	6,083	1	0	2	124
				T5VS	5,799	2	0	0	118	6,247	2	0	0	127	6,327	2	0	0	129
				T5S	5,804	2	0	0	118	6,252	2	0	0	128	6,332	2	0	1	129
				T5M	5,789	3	0	1	118	6,237	3	0	1	127	6,316	3	0	1	129
				T5W	5,834	3	0	2	119	6,285	3	0	2	128	6,364	3	0	2	130
				BLC	4,572	1	0	1	93	4,925	1	0	1	101	4,987	1	0	1	102
				LCCO	3,402	1	0	2	69	3,665	1	0	2	75	3,711	1	0	2	76
				RCCO	3,402	1	0	2	69	3,665	1	0	2	75	3,711	1	0	2	76
P3	20	1050	71W	T1S	7,833	2	0	2	110	8,438	2	0	2	119	8,545	2	0	2	120
				T2S	7,825	2	0	2	110	8,429	2	0	2	119	8,536	2	0	2	120
				T2M	7,865	2	0	2	111	8,473	2	0	2	119	8,580	2	0	2	121
				T3S	7,617	2	0	2	107	8,205	2	0	2	116	8,309	2	0	2	117
				T3M	7,846	2	0	2	111	8,452	2	0	2	119	8,559	2	0	2	121
				T4M	7,675	2	0	2	108	8,269	2	0	2	116	8,373	2	0	2	118
				TFTM	7,841	2	0	2	110	8,447	2	0	2	119	8,554	2	0	2	120
				T5VS	8,155	3	0	0	115	8,785	3	0	0	124	8,896	3	0	0	125
				T5S	8,162	3	0	1	115	8,792	3	0	1	124	8,904	3	0	1	125
				T5M	8,141	3	0	2	115	8,770	3	0	2	124	8,881	3	0	2	125
				T5W	8,204	3	0	2	116	8,838	4	0	2	124	8,950	4	0	2	126
				BLC	6,429	1	0	2	91	6,926	1	0	2	98	7,013	1	0	2	99
				LCCO	4,784	1	0	2	67	5,153	1	0	2	73	5,218	1	0	2	73
				RCCO	4,784	1	0	2	67	5,153	1	0	2	73	5,218	1	0	2	73
P4	20	1400	92W	T1S	9,791	2	0	2	106	10,547	2	0	2	115	10,681	2	0	2	116
				T2S	9,780	2	0	2	106	10,536	2	0	2	115	10,669	2	0	2	116
				T2M	9,831	2	0	2	107	10,590	2	0	2	115	10,724	2	0	2	117
				T3S	9,521	2	0	2	103	10,256	2	0	2	111	10,386	2	0	2	113
				T3M	9,807	2	0	2	107	10,565	2	0	2	115	10,698	2	0	2	116
				T4M	9,594	2	0	2	104	10,335	2	0	3	112	10,466	2	0	3	114
				TFTM	9,801	2	0	2	107	10,558	2	0	2	115	10,692	2	0	2	116
				T5VS	10,193	3	0	1	111	10,981	3	0	1	119	11,120	3	0	1	121
				T5S	10,201	3	0	1	111	10,990	3	0	1	119	11,129	3	0	1	121
				T5M	10,176	4	0	2	111	10,962	4	0	2	119	11,101	4	0	2	121
				T5W	10,254	4	0	3	111	11,047	4	0	3	120	11,186	4	0	3	122
				BLC	8,036	1	0	2	87	8,656	1	0	2	94	8,766	1	0	2	95
				LCCO	5,979	1	0	2	65	6,441	1	0	2	70	6,523	1	0	3	71
				RCCO	5,979	1	0	2	65	6,441	1	0	2	70	6,523	1	0	3	71

S1

FEATURES & SPECIFICATIONS

INTENDED USE
The sleek design of the D-Series Size 0 reflects the embedded high performance LED technology. It is ideal for many commercial and municipal applications, such as parking lots, plazas, campuses, and pedestrian areas.

CONSTRUCTION
Single-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. Modular design allows for ease of maintenance and future light engine upgrades. The LED driver is mounted in direct contact with the casting to promote low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP65). Low EPA (0.95 ft^2) for optimized pole wind loading.

FINISH
Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Available in both textured and non-textured finishes.

OPTICS
Precision-molded proprietary acrylic lenses are engineered for superior area lighting distribution, uniformity, and pole spacing. Light engines are available in 3000 K, 4000 K or 5000 K (70 CRI) configurations. The D-Series Size 0 has zero uplight and qualifies as a Nighttime Friendly™ product, meaning it is consistent with the LEED® and Green Globes™ criteria for eliminating wasteful uplight.

ELECTRICAL
Light engine(s) configurations consist of high-efficacy LEDs mounted to metal-core circuit boards to maximize heat dissipation and promote long life (up to L85/100,000 hours at 25°C). Class 1 electronic drivers are designed to have a power factor >90%, THD <20%, and an expected life of 100,000 hours with <1% failure rate. Easily serviceable 10kV surge protection device meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).

STANDARD CONTROLS
The DSX0 LED area luminaire has a number of control options. DSX Size 0, comes standard with 0-10V dimming driver. Dusk to dawn controls can be utilized via optional NEMA twist-lock photocell receptacles. Integrated motion sensors with on-board photocells feature field-adjustable programing and are suitable for mounting heights up to 30 feet.

nLIGHT AIR CONTROLS
The DSX0 LED area luminaire is also available with nLight® AIR for the ultimate in wireless control. This powerful controls platform provides out-of-the-box basic motion sensing and photocontrol functionality and is suitable for mounting heights up to 40 feet. Once commissioned using a smartphone and the easy-to-use CLAIRITY app, nLight AIR equipped luminaries can be grouped, resulting in motion sensor and photocell group response without the need for additional equipment. Scheduled dimming with motion sensor over-ride can be achieved when used with the nLight Eclypse. Additional information about nLight Air can be found here.

INSTALLATION
Included mounting block and integral arm facilitate quick and easy installation. Stainless steel bolts fasten the mounting block securely to poles and walls, enabling the D-Series Size 0 to withstand up to a 3.0 G vibration load rating per ANSI C136.31. The D-Series Size 0 utilizes the AERIS™ series pole drilling pattern (template #8). Optional terminal block and NEMA photocontrol receptacle are also available.

LISTINGS
UL listed to meet U.S. and Canadian standards. UL Listed for wet locations. Light engines are IP66 rated; luminaire is IP65 rated. Rated for -40°C to 50°C ambient with HA option. U.S. Patent No. D672,492 S. International patent pending.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

International Dark-Sky Association (IDA) Fixture Seal of Approval (FSA) is available for all products on this page utilizing 3000K color temperature only.

BUY AMERICAN
Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY
5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	S1 pole

Anchor Base Poles

RSA

ROUND STRAIGHT ALUMINUM

FEATURES & SPECIFICATIONS

INTENDED USE — **These specifications are for USA standards only.** Round Straight Aluminum is a general purpose light pole for up to 30-foot mounting heights. This pole provides a lighter and naturally corrosion-resistant option for mounting area light fixtures and floodlights.

CONSTRUCTION — **Pole Shaft:** The pole shaft is of uniform wall thickness and is one-piece extruded 6063 aluminum alloy with T6 temper. The shaft is uniform in cross-section down length of pole with no taper. Available shaft diameters are 4", 4.5" 5", and 6".

Pole Top: Options include tenon top, drilled for side mount fixture, tenon with drilling (includes extra handhole) and open top. Side drilled and open top poles include a removable aluminum top cap secured with three stainless-steel screws. The top cap resists intrusion of moisture or environmental contaminants.

Handhole: A non-reinforced handhole with grounding provision is provided near the base. Standard positioning varies with shaft width as follows: 4", 4.5", and 5" shaft, handhole at 12"; 6" shaft, handhole at 18" on side A. Positioning the handhole lower than standard may not be possible and requires engineering review; consult Tech Support-Outdoor for further information. All handholes for a pole specified with openings wfor 4" through 6" shaft width has nominal dimension of 2" x 4" with surface mount overlap design.

Bolt Caps/Base Cover: Pole base plate utilizes cast aluminum bolt caps to cover anchor bolt and nut assembly. Spun aluminum covers available as an option.

Anchor Base/Bolts: Anchor base is cast from 356 alloy aluminum and is heat treated to a T6 temper after welding. Anchor bolts are manufactured to ASTM F1554 Standards Grade 55, (55 KSI minimum yield strength and tensile strength of 75-95 KSI). Upper portion of anchor bolt is galvanized per ASTM A-153; bolts have an "L" bend on bottom end and are galvanized a minimum of 12" on the threaded end. Each hot-dipped galvanized anchor bolt is furnished with two hex nuts and two flat washers.

HARDWARE – All structural and non-structural fasteners are stainless-steel.

FINISH – Extra durable painted finish is coated with polyester powder that meets 5A and 5B classifications of ASTM D3359. Standard powder-coat finishes include Dark Bronze, White, Black, Medium Bronze and Natural Aluminum colors. Classic finishes include Sandstone, Charcoal Gray, Tennis Green, Bright Red and Steel Blue colors. Other finishes include Brushed Aluminum, and Anodized Dark Bronze, Anodized Natural Aluminum and Anodized Black. Architectural Colors and Special Finishes are available by quote and include, but are not limited to RAL Colors, Custom Colors and Extended Warranty Finishes. Factory-applied primer paint finish is available for customer field-paint applications.

WARRANTY — 1-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/support/warranty/terms-and-conditions

NOTE: Actual performance may differ as a result of end-user environment and application.
Specifications subject to change without notice.

RSA Round Straight Aluminum Poles

S1 pole

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: RSA 16 4-5C DM19 BA

RSA					
Series	**Nominal fixture mounting height**	**Nominal shaft base size/wall thickness[1]**	**Mounting[1]**	**Options**	**Finish[10]**
RSA	8'-30' (for 1/2 ft increments, add -6 to the pole height. Ex: 20-6 equals 20ft 6in.) (See technical information table for complete ordering information.) 14 feet	4C 4" (.125") 4-5C 4 1/2" (.125") 4-5G 4 1/2" (.188") 5C 5" (.125") 5E 5" (.156") 5G 5" (.188") 6E 6" (.156") 6G 6" (.188") (See technical information table for complete ordering information.)	Tenon mounting PT Open top T20 2-3/8" O.D. (2" NPS) T25 2-7/8" O.D. (2-1/2" NPS) T30 3-1/2" O.D. (3" NPS)[2] T35 4" O.D. (3-1/2" NPS)[2] KAC/KAD/KSE/KSF/KVR/KVF Drill mounting[3] DM19 1 at 90° DM28 2 at 180° DM28PL 2 at 180° with one side plugged DM29 2 at 90° DM32 3 at 120° DM39 3 at 90° DM49 4 at 90° CSX/DSX/RSX/AERIS™/OMERO™/HLA/KAX Drill mounting[3] DM19AS 1 at 90° DM28AS 2 at 180° DM29AS 2 at 90° DM32AS 3 at 120° DM39AS 3 at 90° DM49AS 4 at 90° RAD drill mounting[3] DM19RAD 1 at 90° DM28RAD 2 at 180° DM29RAD 2 at 90° DM32RAD 3 at 120° DM39RAD 3 at 90° DM49RAD 4 at 90° ESX Drill mounting[3] DM19ESX 1 at 90° DM28ESX 2 at 180° DM29ESX 2 at 90° DM39ESX 3 at 90° DM49ESX 4 at 90° AERIS™ Suspend drill mounting[3,4] DM19AST_ 1 at 90° DM28AST_ 2 at 180° DM29AST_ 2 at 90° DM39AST_ 3 at 90° DM49AST_ 4 at 90° OMERO™ Suspend drill mounting[3,4] DM19MRT_ 1 at 90° DM28MRT_ 2 at 180° DM29MRT_ 2 at 90° DM39MRT_ 3 at 90° DM49MRT_ 4 at 90°	Shipped installed L/AB Less anchor bolts (Include when anchor bolts are not needed) VD Vibration damper TP Tamper resistant handhole cover fasteners HAxy Horizontal arm bracket (1 fixture)[5,6] FDLxy Festoon outlet less electrical[5] CPL12/xy 1/2" coupling[5] CPL34/xy 3/4" coupling[5] CPL1/xy 1" coupling[5] NPL12/xy 1/2" threaded nipple[5] NPL34/xy 3/4" threaded nipple[5] NPL1/xy 1" threaded nipple[5] EHHxy Extra handhole[5,7] MAEX Match existiing [8] USPOM United States point of manufacture[9] UL UL listed with label (Includes NEC compliant cover) NEC NEC 410.30 compliant gasketed handhole (Not UL Labeled) Shipped separately (replacement kit available) (blank) BLTC Bolt caps FBC Full base cover (spun aluminum) (blank) TC Top cap (with drill-mount poles) (blank) HHC Handhole cover	Standard colors DDBXD Dark bronze DWH White DBLXD Black DMB Medium bronze DNA Natural aluminum BA Brushed aluminum Classic colors DSS Sandstone DGC Charcoal gray DTG Tennis green DBR Bright red DSB Steel blue Class 1 architectural anodized ABL Black ADB Dark bronze ANA Natural Architectural Colors and Special Finishes[10] Duranodic Anodize, Paint over Duranodic Anodize, RAL Colors, Custom Colors and Extended Warranty Finishes available.

NOTES:

1. Wall thickness will be signified with a "C", "E" or a "G" in nomenclature. "C" - 0.125 | "E" - 0.156 | "G" - 0.188.
2. PT open top poles include top cap. When ordering tenon mounting and drill mounting for the same pole, follow this example: DM28/T20. The combination includes a required extra handhole.
3. Refer to the fixture spec sheet for the correct drilling template pattern and orientation compatibility.
4. Insert "1" or "2" to designate fixture size; e.g. DM19AST2.
5. Specify location and orientation when ordering option.
   For "x": Specify the height above the base of pole in feet or feet and inches; separate feet and inches with a "-".
   Example: 5ft = 5 and 20ft 3in = 20-3
   For "y": Specify orientation from handhole
   (A,B,C,D) Refer to the Handhole Orientation diagram below.
   Example: 1/2" coupling at 5' 8", orientation C = CPL12/5-8C
6. Horizontal arm is 18" x 2-3/8" O.D. tenon standard with radius curve providing 12' rise. If ordering two horizontal arm at the same height, specify with HAxyy. Example: HA20BD
7. Combination of tenon-top and drill mount includes extra handhole.
8. Must add original order number of existing pole(s).
9. Use when mill certifications are required.
10. Additional colors available; see www.lithonia.com/archcolors or Architectural Colors brochure (Form No. 794.3). Available by formal quote only, consult factory for details.

RSA Round Straight Aluminum Poles

S1 pole

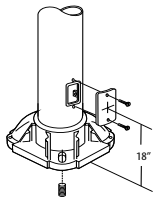
TECHNICAL INFORMATION — EPA (ft^2) with 1.3 gust									
Catalog number	Nominal mount ht. (ft) *	Pole shaft size (in x ft)	Wall thick (in)	EPA (ft^2) with 1.3 gust			Max. weight (lbs)	Bolt size (in. x in. x in.)	Approximate ship (lbs.)
				80 mph	90 mph	100 mph			
RSA 8 4C	8	4 x 8	0.125	11.2	8.6	6.8	125	3/4 x 18 x 3	22
RSA 8 4-5C	8	4-1/2 x 8	0.125	14.6	11.3	9.1	175	3/4 x 18 x 3	30
RSA 8 4-5G	8	4-1/2 x 8	0.188	21.8	17	13.7	225	3/4 x 18 x 3	38
RSA 10 4C	10	4 x 10	0.125	8.2	6.1	4.7	100	3/4 x 18 x 3	26
RSA 10 4-5C	10	4-1/2 x 10	0.125	10.6	8.1	6.5	133	3/4 x 18 x 3	34
RSA 10 4-5G	10	4-1/2 x 10	0.188	16.3	12.6	10.1	175	3/4 x 18 x 3	43
RSA 10 5C	10	5 x 10	0.125	13.6	10.6	8.5	150	3/4 x 18 x 3	36
RSA 12 4C	12	4 x 12	0.125	6	4.3	3.2	110	3/4 x 18 x 3	30
RSA 12 4-5C	12	4-1/2 x 12	0.125	8.1	6	4.8	80	3/4 x 18 x 3	38
RSA 12 4-5G	12	4-1/2 x 12	0.188	12.7	9.7	7.7	185	3/4 x 18 x 3	50
RSA 12 5C	12	5 x 12	0.125	10.3	8	6.3	150	3/4 x 18 x 3	36
RSA 12 5E	12	5 x 12	0.156	13.2	10.3	8.2	200	3/4 x 18 x 3	44
RSA 12 5G	12	5 x 12	0.188	16.2	12.6	10.1	225	3/4 x 18 x 3	53
RSA 14 4C	14	4 x 14	0.125	4.1	2.8	1.9	75	3/4 x 18 x 3	35
RSA 14 4-5C	14	4-1/2 x 14	0.125	5.8	4.2	3.3	60	3/4 x 18 x 3	39
RSA 14 4-5G	14	4-1/2 x 14	0.188	9.7	7.3	5.8	190	3/4 x 18 x 3	56
RSA 14 5C	14	5 x 14	0.125	7.8	6	4.7	100	3/4 x 18 x 3	42
RSA 14 5E	14	5 x 14	0.156	10.3	8	6.3	125	3/4 x 18 x 3	47
RSA 14 5G	14	5 x 14	0.188	12.8	9.9	7.9	150	3/4 x 18 x 3	56
RSA 16 4C	16	4 x 16	0.125	2.8	1.6	1	150	3/4 x 18 x 3	38
RSA 16 4-5C	16	4-1/2 x 16	0.125	3.3	2.2	1.6	100	3/4 x 18 x 3	46
RSA 16 4-5G	16	4-1/2 x 16	0.188	7.5	5.5	4.3	155	3/4 x 18 x 3	62
RSA 16 5C	16	5 x 16	0.125	5.9	4.4	3.4	175	3/4 x 18 x 3	46
RSA 16 5E	16	5 x 16	0.156	8	6.1	4.8	190	3/4 x 18 x 3	53
RSA 16 5G	16	5 x 16	0.188	10.1	7.8	6.1	200	3/4 x 18 x 3	60
RSA 16 6E	16	6 x 16	0.156	13.6	10.6	8.4	225	3/4 x 30 x 3	53
RSA 16 6G	16	6 x 16	0.188	16.8	13	10.4	245	3/4 x 30 x 3	78
RSA 18 5G	18	5 x 18	0.188	8	6.8	4.7	225	3/4 x 18 x 3	68
RSA 18 5C	18	5 x 18	0.125	4.3	3.1	2.4	150	3/4 x 18 x 3	48
RSA 18 5E	18	5 x 18	0.156	6.1	4.6	3.5	175	3/4 x 18 x 3	58
RSA 18 4-5G	18	4-1/2 x 18	0.188	5.7	4	3.1	123	3/4 x 18 x 3	68
RSA 18 6G	18	6 x 18	0.188	13.9	10.7	8.5	225	3/4 x 30 x 3	86
RSA 20 4-5G	20	4-1/2 x 20	0.188	4.3	2.9	2.1	95	3/4 x 18 x 3	74
RSA 20 5C	20	5 x 20	0.125	3	2.1	1.5	150	3/4 x 18 x 3	54
RSA 20 5E	20	5 x 20	0.156	4.7	3.4	2.6	150	3/4 x 18 x 3	68
RSA 20 5G	20	5 x 20	0.188	6.4	4.8	3.6	150	3/4 x 18 x 3	82
RSA 20 6E	20	6 x 20	0.156	9.3	7.1	5.5	175	3/4 x 30 x 3	95
RSA 20 6G	20	6 x 20	0.188	11.8	9.1	7.1	200	3/4 x 30 x 3	110
RSA 25 4-5G	25	4-1/2 x 25	0.188	1.3	--	--	100	3/4 x 18 x 3	89
RSA 25 6E	25	6 x 25	0.156	5.2	3.8	2.8	150	3/4 x 30 x 3	108
RSA 25 6G	25	6 x 25	0.188	7.1	5.3	4	150	3/4 x 30 x 3	128
RSA 30 6G	30	6 x 30	0.188	3.5	2.4	1.6	200	3/4 x 30 x 3	146

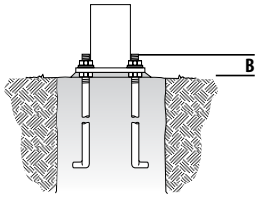
* TECHNICAL INFORMATION — EPA (ft2) with 1.3 gust. For 1/2 ft increments, add -6 to the pole height. Ex: 20-6 equals 20ft 6in.

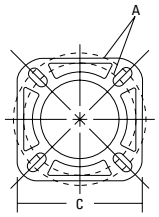
RSA Round Straight Aluminum Poles

S1 pole

BASE DETAIL

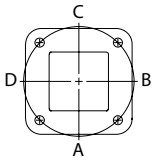






POLE DATA					
Shaft base size	Bolt circle A	Bolt projection B	Base square C	Template description	Anchor bolt description
4"	6.75" - 8.00"	3.25"	8.91"	ABTEMPLATE PJ50057	AB18-0
4.5"	7.06" - 8.62"	3.25"	9.26"	ABTEMPLATE PJ50040	AB18-0
5"	7.75" - 8.00"	3.25"	9.61"	ABTEMPLATE PJ50058	AB18-0
6"	9.00"-10.00"	3.50"	10.32"	ABTEMPLATE PJ50059	AB30-0

HANDHOLE ORIENTATION



Default DM19 is on side B.

Handhole

IMPORTANT INSTALLATION NOTES:

- Do not erect poles without having fixtures installed.
- Factory-supplied templates must be used when setting anchor bolts. Lithonia Lighting will not accept claim for incorrect anchorage placement due to failure to use factory template.
- If poles are stored outside, all protective wrapping must be removed immediately upon delivery to prevent finish damage.
- Lithonia Lighting is not responsible for the foundation design.

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	X

FEATURES & SPECIFICATIONS

INTENDED USE — Ideal for applications requiring attractive die-cast aluminum signage, superior illumination and low energy consumption.

CONSTRUCTION — Precision-molded, die-cast aluminum construction — ultra-slim, compact housing. Fine-grain brushed aluminum faceplate with matte black electrostatic polymeric trim. Clear lacquer finish on brushed face inhibits fingerprints and other surface contaminants.

All electronics located inside housing.

Fully overlapping light seal prevents light leaks. Universal directional chevron knockouts are completely concealed and easily removed. Hinged faceplate and spring latches for easy lamp compartment access, no exposed hardware.

Letters 6" high with 3/4" stroke, with 100 ft viewing distance rating, based upon UL924 standards.

U.S. Patent No. 5,739,639, 5,954,423 and 6,502,044. Canada Patent No. 2,204,218. Other patents pending.

OPTICS — Lamp is constructed using new LED technology. Provides perfectly uniform illumination to meet 3/4" letter stroke required by code.

The typical life of the exit LED lamp is 10 years, based on continuous operation. Unique LED lamp platform accommodates both single-face and double-face exits.

Low energy consumption — red exit consumes std .81W, 1.3W (120V), green exit consumes std is 1W, 1.5W (120V). Universal input voltage capabilities (120V through 277V, 50 or 60 HZ).

ELECTRICAL — Solid-state electronic elements to eliminate risk of electromechanical failures.

Surge protection meets ANSI/IEEE C62.41 category B and IEC 1000 immunity standards for high voltage surges, electrostatic discharges, high frequency electrical fast transients and line voltage dips/swells.

Emergency Operation (for EL N option only): Battery: Sealed, maintenance-free nickel-cadmium battery delivers 90 minutes capacity to lamp.

Self-diagnostics (SD option only): Two-state constant-current charger maximizes battery life and automatically recharges after battery discharge. Test switch provided for manual testing.

Self-diagnostic testing for five minutes every 30 days, 30 minutes at 180-day interval, and 90 minutes annually.

Diagnostic evaluation of LED light source, AC to DC transfer, charging and battery condition.

Continuously monitors AC functionality.

Low voltage disconnect prevents excessive deep discharge that can permanently damage the battery.

Single-point microcomputer control for all electronic features.

Crystal oscillator timing system with watchdog protection for precision accuracy.

AC/LVD reset allows battery connection before AC power is applied and prevents battery damage from deep discharge.

Brownout protection is automatically switched to emergency mode when supply voltage drops below 80% of nominal.

Single multi-chromatic LED indicator to display two-state charging, test activation and three-state diagnostic status.

Test switch provides manual activation of 30-second diagnostic testing for on-demand visual inspection.

LE surface

LRE recessed

Signature®

Die-Cast Aluminum Exits

LE and LRE

LED NEMA Premium

INSTALLATION — Universal mounting (top, end or back). Double face available with top or end mounting only. LRE: Trim ring has 3/4" depth adjustment to ensure a flush fit against the surface. Protrudes 1/10" from the surface. No exposed hardware.

Die-cast aluminum canopy provided for surface mount only.

LISTINGS — UL damp location listed 50°F - 104°F (10°C - 40°C). Meets UL 924, NFPA 101 (current Life Safety Code), NEC and OSHA illumination standards. North Carolina Department of Insurance. NEMA Premium certified.

WARRANTY — 5-year limited warranty. (Battery is prorated.) Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Note: Specifications subject to change without notice.

Provide according to drawings

ORDERING INFORMATION For shortest lead times, configure products using **bolded options**.

Example: LE S 1 R EL N SD

Series	Face type	Housing color	Number of faces	Letter color	Input voltage	Operation	Options
LE LED, surface mount	**S** Stencil	**(blank)** Matte black, brushed aluminum face	**1** Single face	**R** Red	**(blank)** Universal input voltage (120-277V, 50 or 60 HZ)	**(blank)** AC only	(blank) None
LRE LED, recessed	P Panel [1]	BZ Dark bronze [2]	**2** Double face [2]	**G** Green		EL N Nickel-cadmium battery back-up	TP Two tamper proof Torx-head screws
		W White				X2 Lamp wired on two separate AC circuits [3]	VR Vandal-resistant shield (1/8" thick polycarbonate) [4]
		B Matte black [2]					FI FA Field selectable fire alarm interface or flashing emergency operation with intermittent audible alarm (one flash per minute) [5]
							FI Fire alarm flashing interface [6]
							FA Flashing emergency operation and intermittent audible alarm [7]
							SD Self-diagnostics [7]

Accessories: *Order as separate catalog number.*

ELA US12	12" stem kit (see spec sheet ELA-StemKits) [2,8]	ELA LEHO 120/277 N	Remote-capable exit with black canopy; provides 90 minutes of 11.1W capacity for remote head [2,8]
ELA WG1	Back-mount wire guard (see spec sheet ELA-WG) [2]	ELA ERK	Recess mounting rough-in kit for LRE only (see spec sheet ELA-ERK-LEHO)
ELA WGEXT	Top-mount wire guard (see spec sheet ELA-WG) [2]		
ELA WGEXE	End-mount wire guard (see spec sheet ELA-WG) [2]		

Notes

1. Panel face available for special wording only (see Custom Signage spec sheet).
2. Not available with LRE models.
3. UL Listed as emergency lighting.
4. VR contains tamper proof screws.
5. Available with SD option only.
6. Available with AC only or EL N option only.
7. Available with EL N option only.
8. Add W for white.

LE-LRE LED, Signature

SPECIFICATIONS

ELECTRICAL				
Primary circuit				
Type	**Typical LED life[1]**	**Supply voltage**	**Input watts**	**Max. amps**
Red LED AC only	10 Years	120	0.81	0.05
		277	1.2	0.06
Green LED AC only	10 Years	120	1.05	0.05
		277	1.32	0.06
Red LED emergency	10 Years	120	1.3	0.06
		277	1.4	0.07
Green LED emergency	10 Years	120	1.5	0.07
		277	1.7	0.07

BATTERY			
Sealed Nickel-Cadmium			
Shelf life[2]	**Typical life[2]**	**Maintenance[3]**	**Optimum temperature[4]**
3 years	7-9 years	none	50°F – 104°F (10°C – 40°C)

Notes

1 The typical life of the exit LED lamp is 10 years, based on continuous operation.

2 At 77°F (25°C).

3 All life safety equipment, including emergency lighting for path of egress must be maintained, serviced, and tested in accordance with all National Fire Protection Association (NFPA) and local codes. Failure to perform the required maintenance, service, or testing could jeopardize the safety of occupants and will void all warranties.

4 Optimum ambient temperature range where unit will provide capacity for 90 minutes. Higher and lower temperatures affect life and capacity.

SELF-DIAGNOSTICS
(SD option only)

- Five-minute test every 30 days
- 30-minute test every six months
- 90-minute test annually
- Diagnostics evaluate the battery, lamp, charger and AC to DC transfer.

Condition	Indication
Normal mode	Steady green
Self-testing	Flashing green
Emergency mode	Off
Hi-charge	Steady red
Battery failure	Single-flash red
Lamp failure	Double-flash red
Circuit failure	Triple-flash red

KEY FEATURE

The typical life of the exit LED lamp is 10 years.

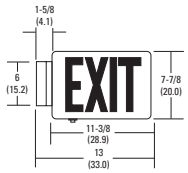
MOUNTING

All dimensions are in inches (centimeters). For VR option, add 1/4" to height and width. Add 1/8" depth for single face; 1/4" depth for double face.

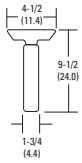
Shipping weight: LE - 4 lbs (1.8 kgs)
LE EL N- 5 lbs (2.3 kgs)
LRE - 4 lbs (1.8 kgs)
LRE EL N - 5 lbs (2.3 kgs)

X

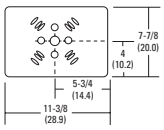
LE - End Mounting



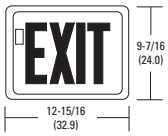
LE - Top Mounting

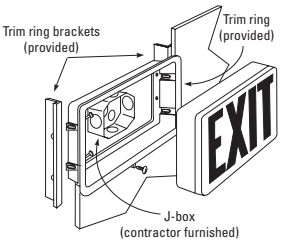


LE - Back Mounting



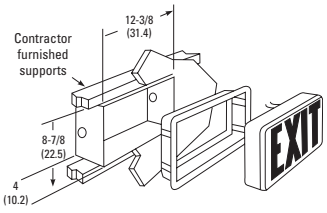
STANDARD MOUNTING





Wall opening dimensions: 8-3/4" H x 12-3/8" W x 1-3/4" D

MOUNTING WITH OPTIONAL ROUGH-IN KIT (ELA ERK)



Wall opening dimensions: 8-7/8" H x 12-3/8" W x 4" D

LITHONIA LIGHTING®
An AcuityBrands Company

EMERGENCY: One Lithonia Way, Conyers, GA 30012 Phone: 800-334-8694 Fax: 770-981-8141 www.lithonia.com

SECTION 27 0500
COMMUNICATIONS GENERAL REQUIREMENTS

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 of this section.

B. BICSI Communications Distribution Methods Manual (TDMM), Eleventh Edition.

1.2 SUMMARY

A. This Section includes communications general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.3 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate the installation of the communications wiring devices, equipment, supports, pathways etc., with all other trades prior to installation. Verify and coordinate routing of cable trays, conduits, wireways, etc., intended to support routings of communications cabling.

1.4 DRAWINGS

A. The drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions.

C. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect.

D. The architectural and structural drawings take precedence in all matters pertaining to the building structure, mechanical drawings in all matters pertaining to mechanical trades and electrical drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the drawings for the various trades, report such conflicts or differences to the Architect for resolution.

1.5 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the work must be conducted before submitting proposal.

B. The submitting of a proposal implies that the contractor has visited the site and understands the conditions under which the work must be conducted.

1.6 TEMPORARY FACILITIES

A. Maintain all required services that need to remain operational during demolition and construction. Coordinate required services with Construction Manager before the start of the project.

1.7 GUARANTEE

A. Contractor guarantees that the installation is free from defects and agrees to replace or repair, any part of this installation which becomes defective within a period of twenty years following final acceptance, provided that such failure is due to defects in the equipment, material or installation or to follow the specifications and drawings. File with Macomb Community College (MCC) any and all guarantees from the equipment manufacturers.

B. Fulfill manufacturer requirements for warranty and File with MCC any and all guarantees from the equipment manufacturers. See Appendix A (Commscope Enterprise Warranty).

1.8 STANDARDS OF MATERIAL AND WORKMANSHIP:

A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. A.N.S.I. American National Standards Institute
2. A.S.T.M. American Society for Testing Materials
3. BICSI Building Industry Consulting Services International
4. I.C.E.A. Insulated Cable Engineer’s Association
5. I.E.E.E. Institute of Electrical and Electronics Engineers
6. N.E.C. National Electrical Code
7. N.E.M.A. National Electrical Manufacturer's Association
8. TIA/EIA Communications Industry Association/Electronic Industries Association
9. U.L. Underwriters Laboratories, Inc.

B. Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the Trades involved.

C. All equipment of the same or similar systems shall be by the same manufacturer.

1.9 RECORD DRAWINGS

A. Provide complete operating and maintenance instruction manuals covering all communications equipment herein specified, together with parts lists. All literature shall be furnished in triplicate for Owner and shall be bound in book or ring binder form as directed by Architect/Engineer.

B. The operating and maintenance instructions shall include a brief, general description for all electrical systems including, but not limited to:
   1. Routine maintenance procedures.
   2. Trouble-shooting procedures.
   3. Contractor's telephone numbers for warranty repair service.
   4. Shop drawings.
   5. Recommended spare parts lists.
   6. Names and telephone numbers of major material suppliers.

C. Provide certified test records for all installed cable showing compliance with specifications. Provide in single bound volume arranged by function and geographic location.

1.10 MATERIAL AND EQUIPMENT MANUFACTURERS

A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of communications equipment and shall be of the manufacturer's latest design.

B. Substitutions are not allowed.

1.11 SHOP DRAWINGS/SUBMITTALS

A. All shop drawings shall be submitted in groupings of similar and/or related items (cable and connectors, equipment cabinets and racks, etc.). Incomplete submittal groupings will be returned unchecked.

B. Provide detailed layout shop drawings of backbone and horizontal cabling distribution, pathways and equipment room layouts. Include riser diagrams, details and related information necessary for installation and maintenance.
   1. Provide plan drawings in AutoCAD format

C. Submit for approval shop drawings for all communications systems or equipment but not limited to the items listed below. Where items are referred to by symbolic designation on the drawings and specifications, all submittals shall bear the same designation. Refer to other sections of the specifications for additional requirements.
   1. Structured cabling system components including J-hooks, cable runway, cable management, innerduct, etc.
   2. Equipment racks and cabinets including management components
   3. Labeling equipment
   4. Plan layouts including detailed equipment room layouts

1.12 USE OF EQUIPMENT

A. The use of any equipment or any part thereof for purposes other than testing even with MCC’s consent shall not be construed to be an acceptance of the work on the part of MCC, nor be construed to obligate MCC in any way to accept improper work or defective materials.

1.13 WORK PROVIDED BY OTHERS

A. Conduit, cabletrays, sleeves, boxes, floor boxes, surface raceways and grounding shall be provided by the Electrical Contractor under Division 26.

B. Coordinate installation of communications work with work provided by Electrical Contractor in paragraph A above.

1.14 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. Cabling Installer must have personnel on staff that provide direct supervision with a current Commscope Authorized SYSTIMAX Engineer (ASE) badge. All installers must have current SYSTIMAX Installation and Maintenance Certification.

B. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of an RCDD and shall be coordinated thru MCC's Communications Information Technology department.

C. Installation Supervision: Installation shall be under the direct supervision of Commscope Authorized SYSTIMAX Engineer.

D. Field Inspector: Shall be currently registered by BICSI as RCDD to perform the on-site inspection.

E. 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.

F. Communications Pathways and Spaces: Comply with TIA/EIA-569-A.

G. Grounding: Comply with ANSI-J-STD-607-A.

1.15 CONTRACTOR QUALIFICATIONS

A. The Installing Contractor for each communications system shall have a minimum of 5 years of experience with the types of systems specified.

B. The Installing Contractor shall submit with the bid the names and registration numbers of members of the firm that have a valid membership and are certified with BICSI as registered Communications Distribution Designers (RCDD). This contractor shall identify at least one RCDD assigned to this project in the bid.

C. The bidding, shop drawing submittal, procurement of materials, the installation as-builts and record documents shall be reviewed and overseen by the RCDD(s) assigned to the project.

D. The contractor's bid, shop drawing submittals, as-builts and record documents shall bear the valid seal of the RCDD(s) assigned to this project.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 INSTALLATION OF EQUIPMENT

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the drawings and specifications, report such conflicts to the Architect/Engineer for resolution.

3.2 REMOVAL/DEMOLITION WORK

A. All removal/demolition of existing communications equipment and materials shall be done by this contractor unless otherwise indicated. Include all items such as, but not limited to, cable, patch panels, devices, and wiring called out on the drawings and as necessary whether such items are actually indicated on the drawings or not in order to accomplish the installation of the specified new work.

B. In general, removal/demolition work is indicated on the drawings. However, the contractor shall visit the job site to determine the full extent and character of this work.

C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of MCC unless such ownership is waived. Items on which MCC waives ownership shall become the property of the contractor, who shall remove and legally dispose of same, away from the premises.

D. Where equipment or fixtures are removed, outlets shall be properly blanked off, and conduits capped. After alterations are done, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present systems to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.

E. Reroute signal wires, lighting and power wiring as required to maintain service. Where walls and ceilings are to be removed as shown on the drawings, the conduit is to be cut off by the Electrical Trades so that the abandoned conduit in these walls and ceilings may be removed with the walls and ceilings by the Architectural Trades. All dead-end conduit runs shall be plugged at the remaining outlet boxes or at the panels.

F. Where new walls and/or floors are installed which interfere with existing communications outlets, devices, etc., this contractor shall adjust, extend and reconnect such items as required to maintain continuity of same.

G. Where existing racks are being removed, turn over to MCC.

H. Existing fiber patch panel shall be maintained in existing or temporary location. Coordinate with construction documents.

I. Wireless access points shall be removed and stored during demolition and construction. Wireless access points will be reused in new work where indicated in the construction documents.

3.3 WORK IN EXISTING BUILDINGS

A. MCC will provide access to existing buildings as required. However, this contractor, once work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.

B. Adequately protect and preserve all existing and newly installed work. Promptly repair any damage to same at this contractor's expense.

C. Consult with Construction Manager as to the methods of carrying on the work so as not to interfere with MCC's operation any more than absolutely necessary. Accordingly, all communications services shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by Construction Manager.

3.4 COORDINATION

A. Install work to avoid interference with work of other trades including, but not limited to, architectural, mechanical and electrical trades. Remove and relocate any work that causes interference at this contractor's expense. Disputes regarding the cause of interference will be resolved by Construction Manager or Architect/Engineer.

3.5 CHASES AND RECESSES

A. Chases and recesses shall be provided by the Architectural Trades, but this contractor shall be responsible for coordinating their accurate location and size.

3.6 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

A. Refer to General Conditions for requirements.

B. All cutting, patching and repair work shall be performed by the contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.7 ACCESS DOORS

A. Provide access doors for installation by architectural trades. In the walls, provide Milcor No. "DW" or "M" as required to make all controls, electrical boxes and other equipment installed by the contractor accessible. Minimum size 12 inches x 12 inches. In the ceiling, provide Milcor No. 3210, 3105 or 3206 for accessibility as mentioned above, 24 inches x 24 inches minimum size. The plaster or acoustical tile insert shall be by the architectural trades. Areas with accessible ceilings (ceilings where tiles are not fastened

in place and can be individually removed without removal of adjacent tiles) will not require access doors.

B. When access doors are in fire resistant wall or ceilings, they must bear the Underwriters Laboratories, Inc., Label, with time design rating equal to or exceeding that of the wall or ceiling unless they were a part of the tested assembly.

3.8 CLEANING

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

B. Final cleanup shall include, but not be limited to, cleaning all communications equipment spaces, devices, cover plates, and removing all scrap cable and debris from pathways.

3.9 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

A. Equipment and materials shall be protected from theft, injury or damage.

B. Protect conduit openings with temporary plugs or caps.

C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by Construction Manager or Architect. Equipment set in place in unprotected areas must be provided with temporary protection.

3.10 DRAWINGS AND MEASUREMENTS

A. These Specifications and accompanying drawings are intended to describe and provide for finished work. They are intended to be cooperative, and what is called for by either shall be as binding as if call for by both. The Contractor will understand that the work herein described shall be complete in every detail.

B. The drawings are not intended to be scaled for rough-in measurements or to serve as Shop Drawings. Field measurements, necessary for ordering materials and fitting the installation to the building construction and arrangement, shall be taken by this contractor.

END OF SECTION 27 0500

SECTION 27 1100
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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. Communications mounting elements.
      a. Backboards
      b. Communications equipment racks and cabinets.
   2. Communications Equipment Room Configuration
      a. Communications service entrance pathways.
      b. Layout
      c. Security
   3. Grounding.

B. Related Sections:
   1. Section 27 1500 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.
   2. Section 27 0536 "Cable Trays for Communications Systems" for cable trays and accessories.
   3. Section 27 1300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
B. Ladder Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
C. LAN: Local area network.
D. RCDD - Registered Communications Distribution Designer.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: For communications equipment room sittings, 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. Equipment Racks: Include workspace requirements and access for cable connections.
   3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and work above ceilings is complete.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.
B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
   1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke producing characteristics.
   2. Support brackets with cable tie slots for fastening cable ties to brackets.
   3. J-hooks
   4. Straps and other devices
C. Cable Support not permitted:
   1. Bridal rings

2.2 BACKBOARDS

A. Utility Mounting Board, refer to architectural.

2.3 CABLE MANAGEMENT

A. Vertical rack cable management, comply with following specifications:
   1. Construction: Allows patch cords to be organized by rack-mount space, enabling an easier tracing of individual cables during moves, additions, and changes
   2. Frame: High strength aluminum
   3. Cover: Snap-on construction, which opens to left or right
   4. Cable openings: 1 RU (44.5 millimeters (1.75 inches) high openings, edge-protected cable ports, and slots for cable straps. Cable openings shall align with rack mounting spaces in cabinet.

5. Hardware: includes square neck carriage bolts for one-handed assembly, along with acorn nuts for section attachment screws to protect cables.
6. Cable management spools: Shall be provided to support copper and optical fiber patch cords with following features:
7. Construction: High strength aluminum to resist bending or warping under heavy cable loads.
8. Shape: Circular shape with smooth surface to protect cable sheaths and a front plate to hold cables in position. Spools shall comply with TIA/EIA bend radius requirements.
9. Hardware: Pre-tapped for #10-32 machine screws.
10. Finish: Textured black powder coat

B. Horizontal cable management, comply with following specifications:
1. Construction: Made of high strength aluminum, it provides a horizontal pathway for patch cords and multimedia applications using coaxial, copper, and -optical fiber cables, Cable manager shall have wide contoured cable guides to separate and organize patch cords, enabling an easier tracing of individual cables during moves, additions, and changes.
2. Style: Closed rack-mount trough style, with T-shaped singer openings at top and bottom of trough
3. Cover: Aluminum Snap-on construction
4. Cable openings: Provides flanged pass-through slots to allow routing of patch cords to rear of rack
5. Cable guides: Offset 33 millimeters (1.3 inches) or 66 millimeters (2.6 Inches) from front of rack to maintain required bend radius of cabling
6. Finish: Textured black powder coal

2.4 EQUIPMENT FRAMES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. APW/Wrightline
2. CommSCOPE
3. Chatsworth Products Inc
4. Cooper B-Line, Inc
5. Hubbell Premise Wiring
6. Middle Atlantic Products, Inc
7. Ortronics
8. Panduit
9. Siemon Co. (The).

B. General Frame Requirements:
1. Distribution Frames: Freestanding and wall-mounting, modular units designed for communications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310 standard, 19-inch (480-mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Two-post Floor Mounted Rack
1. Modular-type, aluminum construction, heavy-duty assembly.
2. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug
3. Provide complete ground bar kit with required hardware.
4. Finish: Black powder coat
5. Height: 84”, 45U
6. Width: 19”

D. Four-post Floor Mounted Rack
1. Modular-type, aluminum construction.

2. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug
3. Provide complete ground bar kit with required hardware.
4. Finish: Black powder coat
5. Height: 84", 45U
6. Width: 19"
7. Depth: 29-35"

2.5 UNINTERRUPTIBLE POWER SUPPLY

A. Manufacturer:
   1. APC
B. Management Card:
   1. APC SMX3000RMLV2UNC
      a. Rack mounted.
      b. 3000VA power capacity.
      c. 6.3 min battery run time
      d. 120V input/output voltage
      e. Input Connection: NEMA L5-30P
      f. Output Connections: (3) NEMA 5-15R, (3) NEMA 5-20R, (1) NEMA L5-30R
      g. 3-year warranty
C. Battery Pack:
   1. APC SMX120BP
      a. Rack mounted.
      b. (2) Lead Acid batteries
      c. 120V power supply
      d. 2-year warranty

2.6 FIBER OPTIC TERMINATION PANEL

A. Manufacturer:
   1. Commscope Systimax
B. General specifications:
   1. Systimax HD-2U-FX (760210740) Fixed Modular Cassette Shelf
      a. Rack mounted.
      b. Fixed Shelf
      c. Modular cassette shelf
   2. Provide 96 duplex LC ports.

2.7 CATEGORY 6/CLASS E PATCH PANELS

A. General specifications:
   1. Construct patch panel of high strength steel with black powder finish and design for wall or 19-inch rack mounting. Panels shall be available in 24-port and 48-port configurations, with height of 1 RU of 44.5 millimeters (1.75 inches) for each group of 24 ports. Provide angled configuration with removable rear mounted cable management bar and front and rear identification labels. Patch panel shall be UL listed, ULC certified, and ACMA approved. Unit shall accommodate vertical and horizontal cord organizers available to facilitate patch cord management.
B. Basis of Design Specification:
   1. SYSTIMAX 360 iPatch 1100GS3 Evolve U/UTP Patch Panel, 48 port 360-iP-1100-E-GS3-2U-48 (760201111)
C. Comply with following standards:
   1. TIA/EIA-568-B.1
   2. TIA/EIA-568-B.2
   3. ISO/IEC 11801
   4. CENELEC EN-50173

5. UL, ULC, and ACMA

D. Application standards: Support application standards specified for related cabling.
E. Jacks: Comply with jack requirements specified for related cable category.
F. Performance specifications: Comply with specifications for related cabling.

2.8 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.
B. Communications Main Bus Bar:
   1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
   2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 Inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7,14-mm) holes spaced 11/8 inches (28 mm) apart.
   3. Stand-Off Insulators; Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
C. Comply with ANSI-J-STD-607-A.

2.9 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers. Labels shall be made using a mechanical label maker. Permanent marker, ink pen, and/or pencil labels shall not be accepted. All labels shall be permanent; no hanging/paper tags.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.
B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
C. Cable Trays; Comply with NEMA VE 2 and TIA/EIA-569-A-7.
D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii, install lacing bars and distribution spools.
E. Layout
   1. Room configuration will be laid out in accordance with the Appendix figures 1 thru 5. If any changes are needed to the basic flow and layout of the rooms, then the contractor’s RCDD shall coordinate those changes through MCC’s CIT department.
   2. Meet jointly with LAN equipment suppliers and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
   3. Record agreements reached in meetings and distribute them to other participants.
   4. Adjust arrangements and locations of distribution frames, cross connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of communications equipment.
F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 FIRESTOPPING

A. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."
B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
C. Comply with BJCSI TDMM, "Firestopping Systems" Article.

3.3 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
B. Comply with ANSI-J-STD-607-A.
C. Locate grounding bus bar to minimize the length of bonding conductors, fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar, Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
    1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA606-A. Comply with requirements in Division 26 Section "Electrical Identification."
B. MCC deploys its own labeling scheme. All cabling and terminations shall be labeled as follows:
    1. Equipment (IDF) Room Labeling:
        a. Patch Panels: Each port on each patch panel will have a unique number. Starting at the first patch panel in the rack (at the top of the rack), the port at the left will be port #1. Then the next port will be numbered consecutively as #2, and so on until the last port in that row is numbered. Then the numbering will continue onto the next row. Refer to Image #1 below.

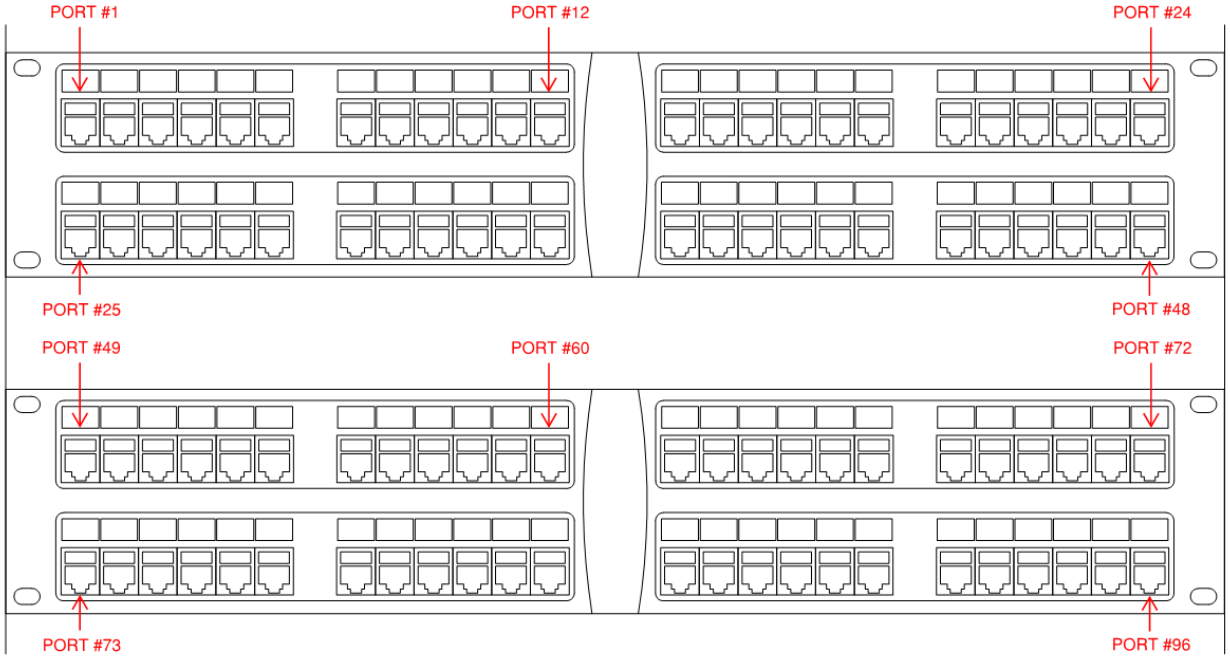


Image #1

        b. Equipment Racks: Provide a printed schedule of all patch panel ports within in the rack with the corresponding jack location. The printed schedule shall be in a protective sleeve and attached to the rack. The printed schedule shall be created in Microsoft Excel. Provide the following columns: Patch Panel Port Number, Telecom Outlet Room Number.
        c. Horizontal Distribution Cables: Each cable entering the equipment room shall be marked with the patch panel port number followed by a hyphen and the room number where the jack or the other end of the cable is located.

2. Telecom Outlet Faceplate Labeling. Provide a label on the faceplate indicating the IDF room that the jacks are served from. Provide a label at each jack with the corresponding patch panel port number. Refer to Image #2.

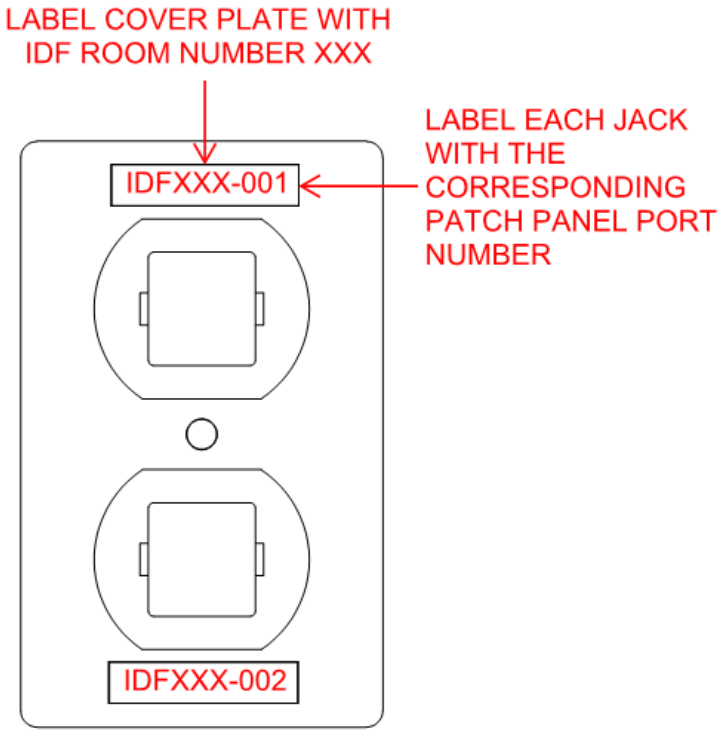


Image #2

3.5 EQUIPMENT RACKS

A. Contractor shall furnish and install wall mounted and floor-mounted equipment racks per manufacturers recommendation.
B. Provide equipment racks of same type, style and finish color as existing, where applicable.
C. Contractor shall permanently install an engraved laminated, phenolic designation plate on each data/telecommunication rack. The plate shall be white with black letters. Helvetica letter heights shall be 3/8".
D. Free standing equipment racks shall be bolted to the floor using anchors in concrete floor and toggle bolts through raised flooring.
E. All racks, cabinets and cable transport hardware shall be bonded to the communications system ground riser.

3.6 CABLE MANAGEMENT

A. Install vertical and horizontal cable management panels per manufacturer's recommendations.
B. Install vertical panels on each side of free-standing equipment racks.
C. Install horizontal patch panels of equivalent quantity as patch panels and of equivalent size, i.e. one rms of cable management panels for one rms of patch panels.

3.7 COMMUNICATIONS CABLE RUNWAY

A. Provide tubular steel cable runway in communications closet as indicated and as required for cable management. Provide all mounting hardware to securely mount to equipment racks, wall, ceiling or structure above, as required. Provide supports recommended by manufacturers and no more than 10 ft O.C.

B. As a minimum, mount runway at each end to wall using appropriate hardware. Where overall length is greater than 10 ft, provide supplemental support from structure above or from equipment racks and cabinets below. Provide additional supports as required to prevent runway from swaying.

C. Mount runway 12” above racks or cabinets unless noted otherwise on drawings.

END OF SECTION 27 1100

SECTION 27 1323
COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

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. OS2 Single-mode, indoor/outdoor plant optical fiber cable.
   2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
   3. Cabling identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
C. RCDD: Registered Communications Distribution Designer.

1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

A. Optical fiber 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.

B. 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.

1.5 SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: Reviewed and stamped by RCDD.
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
   3. Cabling administration drawings and printouts.
   4. Wiring diagrams to show typical wiring schematics including the following:
      a. Telecommunications rooms plans and elevations.
      b. Telecommunications pathways.
      c. Telecommunications system access points.
      d. Telecommunications grounding system.
      e. Cross-connects.
      f. Patch panels.
      g. Patch cords.
   5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
C. Optical fiber cable testing plan.
D. Product Certificates: For each type of product.
E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.8 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.

1.9 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.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 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. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
D. Grounding: Comply with TIA-607-B.

2.2 SINGLE-MODE, INDOOR/OUTDOOR PLANT OPTICAL FIBER CABLE (OS2)

A. Manufacturer: CommScope
B. Description: Single mode, 24-strand fibers, tight buffered, optical fiber cable.
C. Standards:
   1. Comply with TIA-492CAAA for detailed specifications.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Comply with ICEA S-83-596 for mechanical properties.
D. Maximum Attenuation: 1.0 dB/km at 1310 nm; 1.0 dB/km at 1550 nm.
E. Jacket:
   1. Jacket Color: Yellow.
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
F. Armor: Aluminum
G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   2. Riser Rated, Nonconductive: Type OFNP, complying with UL 1666.

2.3 OPTICAL FIBER CABLE HARDWARE

A. Manufacturer: CommScope
B. Standards:
   1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
   2. Comply with TIA-568-C.3.
C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, 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.
D. Patch Cords: LC-LC SM 3 meter fiber cable

E. Connector Type: Type LC anaerobic
F. Plugs and Plug Assemblies:
   1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
   2. Insertion loss not more than 0.25dB.
G. Jacks and Jack Assemblies:
   1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
   2. Insertion loss not more than 0.25dB.

2.4 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.5 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.
B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.
C. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.
D. Cable will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces where unenclosed wiring method may be used.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.
B. General Requirements for Optical Fiber Cabling Installation:
   1. Comply with TIA-568-C.1 and TIA-568-C.3.
   2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
   3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   4. 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.
   5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use 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. In the communications equipment room, provide a 10-foot- long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
B. Comply with TIA-569-D, Annex A, "Firestopping."
C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."
1. Administration Class: Class 2
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.
C. Cable Schedule: Install in a 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 an electronic copy of final comprehensive schedules for Project.
D. 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.
E. 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. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. 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 606-B, for the following:
   1. Flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Tests and Inspections:
   1. Visually inspect optical fiber 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-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Optical Fiber Cable Tests:
      a. Test all fiber strands with Fluke DSX5000 tester and fiber modules for standards compliance.
      b. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
      c. Link End-to-End Attenuation Tests:
         1) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.
C. Data for each measurement shall be documented. 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 it does not comply with specified requirements.
E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.

END OF SECTION 27 1323

SECTION 27 1500
COMMUNICATIONS HORIZONTAL CABLING

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.

B. BICSI Communications Distribution Methods Manual (TDMM), Eleventh Edition.

1.2 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cabling.
3. Optical fiber cabling.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Communications outlet/connectors.
6. Cabling system identification products.
7. Cable management system.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
D. EMI: Electromagnetic interference.
E. IDC: Insulation displacement connector.
F. LAN: Local area network.
G. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
H. RCDD: Registered Communications Distribution Designer.
I. UTP: Unshielded twisted pair.

1.4 GENERAL REQUIREMENTS

A. The structured cabling system (SCS) supporting communications systems shall comply with detailed specifications in this section and shall consist of cabling that may include data backbone optical fiber cables, data backbone copper cables, voice backbone copper cables, patch panels, connecting hardware, horizontal data copper cables, and jacks at TOs for voice, data, and communications system services. Locations of equipment shall be as indicated on drawings, unless directed otherwise by MCC's CIT Department Representative.
B. Locations of equipment shall be as indicated on drawings, unless directed otherwise by Construction Manager.

1.5 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the communications 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-C.1 requires that a minimum of two communications outlet/connectors be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the communications 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 communications 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.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in Microsoft Excel.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics, including the following:
      a. Cross-connects.
      b. Patch panels.
      c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

C. Field quality-control reports.
D. Testing documentation.

1.7 WARRANTY

A. Manufacturers Extended Warranty
   1. SCS Systems will be covered by a two-part certification program provided by a single manufacturer and that manufacturer's certified vendor. Manufacturer shall administer a follow on program through the Vendor to provide support and service to the purchaser. The first part is an assurance program, which provides that the certified system will support the applications for which it is designed, during the 20-year warrantee of the certified system. The second portion of the certification is a 20-year warranty provided by the manufacturer and the vendor on all products within the system (cords, communications outlet/connectors, cables, cross-connects, patch panels, etc.).
   2. In the event that the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading (e.g. ATM), the manufacturer and vendor shall commit to promptly implement corrective action.
   3. Documentation proving the cabling system's compliance to the End-to-End Link Performance recommendations, as listed in ANSITIA/EIA-568-B shall be provided by the Vendor prior to the structured cabling system being installed.
   4. The cabling system must conform to the current issue of industry standard ANSI/TIA/EIA-568. All performance requirements of this document must be followed. As well, workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) ITSI manual.
   5. Purchaser demands strict adherence to the performance specifications listed in ANSI/TIA/EIA-568-B series standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cables to determine the continuity of the strand end to end.
   2. Test each pair of UTP cable for open and short circuits.

1.9 COORDINATION

A. Coordinate communications outlet/connector locations with location of power receptacles at each work area and with other trades.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Horizontal (to desktop) cable shall consist of Category, 6 for all Data and Voice applications. Horizontal fiber optic cable shall not be a standard provision but maybe added as warranted for specific applications.

2.2 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.
B. Cable Support: 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. J-hooks.
C. Innerduct:
   1. Manufacturers:

a. Carlon.
b. Endot.

2. Install innerduct through conduits and sleeves for optical fiber cabling installations.
3. Description: UL listed, non-metallic, corrugated flexible conduit for use in plenum or outdoor installations as applicable. Provide each innerduct with one ¼" W. pulltape with a tensile rating of 900 lbs.
4. Color: Orange

2.3 CATEGORY 6/CLASS E UNSHIELDED TWISTED-PAIR (UTP) CABLE

A. Manufacturers:
1. The basis for the design specifications defined within this document is the CommScope Systimax family of products. The approved model numbers, along with any approved equivalent are listed in tables in Appendix A. Any deviation or substitutions offered as part of this specification must be pre-approved by MCC or MCCs' CIT representative. Any submittals in response to any part of this specification that do not meet the product requirements as defined, may be rejected without further consideration, or may cause monetary charges to be incurred by the submitter.
2. Basis for Design Specification: Systimax GigaSPEED XL cable – See Appendix A for specific product numbers

B. General specifications:
1. Cable shall have a round overall cable geometry with Mylar® bisector tape, and 4 pairs of #23 AWG (0.574 millimeters) bare copper. Cable color shall be blue or white standard colors.

C. Construction specifications (by type):
1. Listed CMP cable: Solid copper conductors with fluorinated ethylene propylene (FEP) insulation and an overall low smoke PVC jacket to achieve plenum rating by applicable NEC requirements.

D. Comply with following general physical specifications:
1. Maximum pulling tension: 110 Newton's (25 pound-force)
2. Operating temperature: –20 to 60 degrees C [–4 to 140 degrees F]

E. Channel performance:
1. Comply with following cable performance specifications. Data shall be guaranteed performance for worst-case channels utilizing 4-pair series cables with full cross-connects, CPs, and work area outlets (i.e., 4 connectors in a channel) for length up to 100 meters (328 feet).

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	ACR (dB)	PSNEXT (dB)	PSACR (dB)	ELFEXT (dB)	PSELFEXT (dB)	Return Loss (dB)	Delay (ns)	Delay Skew (ns)
1.0	2.0	71.0	69.0	69.5	67.5	69.3	68.3	23.0	580	30
4.0	3.8	69.0	65.2	68.0	64.2	57.2	56.2	23.0	562	30
8.0	5.4	64.2	58.8	63.1	57.7	51.2	50.2	23.0	557	30
10.0	6.0	62.6	56.6	61.5	55.5	49.3	48.3	23.0	555	30
16.0	7.6	59.2	51.6	58.1	50.4	45.2	44.2	22.0	553	30
20.0	8.6	57.6	49.1	56.5	47.9	43.2	42.2	21.5	552	30
25.0	9.6	56.0	46.4	54.8	45.2	41.3	40.3	21.0	551	30
31.25	10.8	54.4	43.6	53.2	42.4	39.4	38.4	20.5	550	30
62.5	15.6	49.4	33.7	48.1	32.4	33.3	32.3	18.0	549	30
100.0	20.2	45.9	25.7	44.6	24.3	29.3	28.3	16.0	548	30
200.0	30.0	40.8	10.8	39.4	9.4	23.2	22.2	13.0	547	30
250.0	34.1	39.1	5.0	37.7	3.5	21.3	20.3	12.0	546	30

F. Standards compliance:

1. Comply with following application standards:
    a. Voice, facsimile, modem, Switched 56, T-1, and ISDN
    b. RS-232, RS-422, and RS-485
    c. IEEE 802.3 1Base5, 10BaseT, 100BaseT, 1000BaseT, and 10GBaseT

2.4 CATEGORY 6/CLASS E PATCH CABLE

A. Manufacturers:
    1. The basis for the design specifications defined within this document is the CommScope Systimax family of products. The approved model numbers, along with any approved equivalent are listed in tables in Appendix A. Any deviation or substitutions offered as part of this specification must be pre-approved by MCC or MCCs' CIT representative. Any submittals in response to any part of this specification that do not meet the product requirements as defined, may be rejected without further consideration, or may cause monetary charges to be incurred by the submitter.
    2. Basis for Design Specification: Systimax GigaSPEED XL cable – See Appendix A for specific product numbers.
B. General specifications:
    1. Cable shall have a round overall cable geometry with Mylar® bisector tape, and 4 pairs of #23 AWG (0.574 millimeters) bare copper.
    2. Cable color shall be as follows:
        a. Normal Phone and Computers: Blue
        b. Wireless Access Points: Green
        c. Security Cameras: Red
        d. HVAC: Orange
    3. Length: 9in, 12in, and 18in depending on the port to patch panel distance

2.5 CATEGORY 6/CLASS E OUTLETS

A. General specifications:
    1. Communications jacks shall be 8-position/8-conductor modular outlets accepting industry standard modular RJ45 type plugs and IDC terminations. Universal design shall support T568A and T568B wiring and shall have universal wiring labels, including color-coded insert identification labels to ensure accurate identification. Color shall be orange. Provide improved pair splitters and wider channel for enhanced conductor placement. Jack shall be backward compatible with lower category cords and cables. Low-profile wire cap shall protect against contamination and secure connection. Jacks shall be suitable for:
        a. Modular patching applications or as modular TO
        b. Installation without special faceplates at either 45- or a 90-degree angle in manufacturer's modular faceplates and frames, including those on surface-mounted boxes
        c. Mounting in systems furniture.
    2. Cover plate shall be stainless steel.
B. Basis for Design Specification:
    1. Systimax Solutions MGS400 jack
C. Comply with following physical specifications:
    1. Dimensions: 20 millimeters (0.8 inches) width by 20 millimeters (0.8 inches) height by 31 millimeters (1.2 inches) depth
    2. Material: High-impact, flame-retardant, UL-rated 94 V-0 thermoplastic
    3. Operating temperature: –10 to 60 degrees C (14 to 140 degrees F)
    4. Outlet wire contacts: Copper alloy with 1.27 micrometers (50 microfiches) hard gold plating over 2.54 micrometers (100 microinches) nickel underplate
    5. Connectors: Insulation Displacement Connections shall be industry-standard 110-style Connectors shall accept 0.51 to 0.64 millimeters (0.020 to 0.025 inches), 22 to 24 AWG, stranded conductors or 0.40 to 0.64 millimeters (0.016 to

0.025 inches) 26 to 22 AWG solid conductors with insulation size of 0.76 to 1.17 millimeters (0.030 to 0.046 inches).

D. Comply with following mechanical specifications:
   1. Plug/jack contact force: 100 grams (3.53 ounces) minimum per contact using FCC-approved plug
   2. Plug retention force: 133 newtons (30 pounds-force) minimum
   3. Plug insertion life: 750 insertions minimum
E. Comply with following electrical specifications:
   1. Dielectric withstand voltage: 1000 volts alternating current root mean square, 60 hertz minimum, contact to contact
   2. Insulation resistance: 500 megaohms minimum
   3. Current rating: 1.5 amperes at 20 degrees C (68 degrees F) by IEC 60512-3-1-5b
F. Comply with following standards:
   1. TIA/EIA-568-B.1
   2. TIA/EIA-568-B.2
   3. ISO/IEC 11801
   4. CENELEC EN-50173
   5. UL, CSA, and ACMA
   6. FCC 47 CFR 68 F
G. Application standards: Support application standards specified for related cabling.
H. BAS applications: Comply with specifications for related cabling.
I. Performance specifications: Comply with specifications for related cabling.

2.6 CATEGORY 6/CLASS E OUTLET MOUNTING FRAME

A. Basis for Design Specification:
   1. Commscope M106 Flush Modular Two-Port Mounting Frame in black finish.

2.7 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.

2.8 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.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceways and Boxes."
B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

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.

3.3 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.
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 "Raceways and Boxes" for installation of conduits and wireways.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.
B. General Requirements for Cabling:
   1. Comply with TIA/EIA-568-C.1.
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. MUTOA shall not be used as a cross-connect point.
   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 unreeling. Heat lamps shall not be used for heating.
   10. At the outlet location, install a 5-foot-long service loop in the accessible ceiling above.
   11. At the work area outlet, provide a 12-inch slack loop in each cable.
   12. 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.
D. 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.
E. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in communications 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.

F. Patch Cable Installation:
   1. Provide length of patch cord between port and patch to minimize excess cable length.

G. Group connecting hardware for cables into separate logical fields.

H. 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 Light Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA606-A. Comply with requirements in Division 26 Section "Electrical Identification."

B. MCC deploys its own labeling scheme. All cabling and terminations shall be labeled as follows:
   1. Equipment (IDF) Room Labeling:
      a. Patch Panels: Each port on each patch panel will have a unique number. Starting at the first patch panel in the rack (at the top of the rack), the port at the left will be port #1. Then the next port will be numbered consecutively as #2, and so on until the last port in that row is numbered.

Then the numbering will continue onto the next row. Refer to Image #1 below.

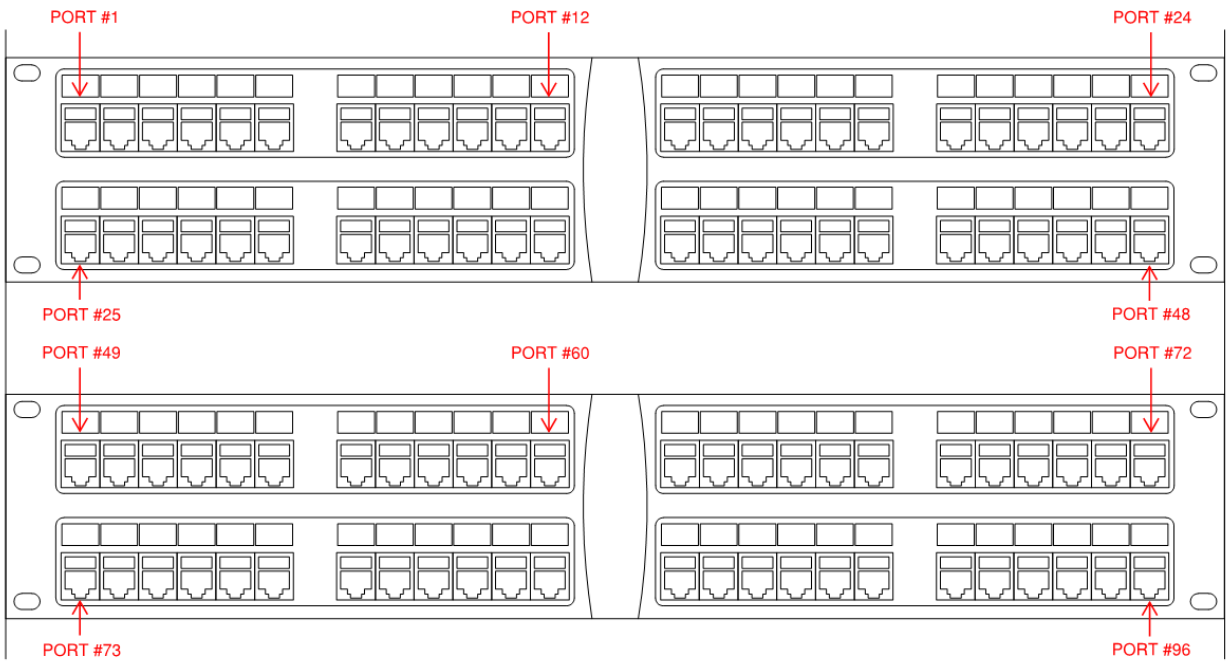


Image #1

b. Equipment Racks: Provide a printed schedule of all patch panel ports within in the rack with the corresponding jack location. The printed schedule shall be in a protective sleeve and attached to the rack. The printed schedule shall be created in Microsoft Excel. Provide the following columns: Patch Panel Port Number, Telecom Outlet Room Number.

c. Horizontal Distribution Cables: Each cable entering the equipment room shall be marked with the patch panel port number followed by a hyphen and the room number where the jack or the other end of the cable is located.

2. Telecom Outlet Faceplate Labeling. Provide a label on the faceplate indicating the IDF room that the jacks are served from. Provide a label at each jack with the corresponding patch panel port number. Refer to Image #2.

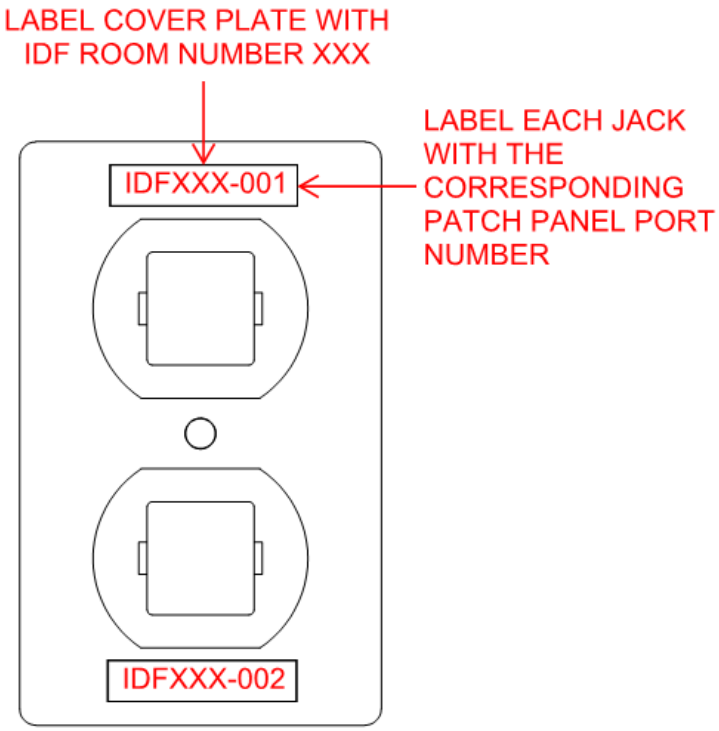


Image #2

C. The contractor shall provide updated As-Built CAD drawings with data drop labeled in As-built following the above identification scheme.

3.8 SYSTEMS TESTING AND DOCUMENTATION

A. General Requirements:
   1. Provide installation testing of equipment where required by manufacturer's installation instructions.
   2. Provide complete end to end testing for all copper and fiber optic systems/channels based on latest applicable standards. Document all testing and submit with final as-built submittal package (see section 27 02 40.50)
   3. For all controls and operating equipment, submit equipment/systems to at least three complete operational sequences, in which all equipment operations are tested, observed, and verified.
   4. Prior to substantial completion and project acceptance inspection, submit test reports to indicated scope of startup and operational tests, with results of testing for each specified operation.

B. Copper Cabling System Testing
   1. General: Copper cabling shall be tested and certified after installation as follows and as required for cable manufacturer's warranty. Twisted-pair copper cable channels shall be tested for continuity as specified below, presence of ac/dc voltage, and performance. All cabling shall be tested for conformance to horizontal cable specifications as outlined herein, and shall be tested according to test set manufacturer's instructions utilizing latest firmware and software. Testing shall include all of electrical parameters as specified under Product. All cables and termination hardware shall be 100 percent tested by installation contractor for defects in installation and to verify cable performance under installed conditions. All conductors of each installed cable shall be verified

useable by Contractor prior to system acceptance. All cables shall be tested according to contract documents, manufacturer's warranty provisions, and best industry practices. If any of these are in conflict, Contractor shall comply with most stringent requirements. All defects in cabling system installation shall be repaired or replaced in order to ensure 100 percent useable conductors in all cables installed, at no additional cost to MCC.

2. Continuity: Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by test unit according to manufacturers' recommended procedures and referenced to appropriate cable identification number and circuit or pair number. Any faults in wiring shall be corrected and cable re-tested prior to final acceptance.
3. Length: Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to maximum distances set forth in TIA/EIA-568-B standards and all other applicable standards specified in Appendix 1: Codes, Standards, and Informative References. Cable lengths shall be recorded, referencing cable identification number and circuit or pair number. For multi-pair cables, shortest pair length shall be recorded as length for cable.
4. Factory testing: Every reel of cable shall be tested by cable manufacturer for all characteristics specified for cable type in this section. This testing shall be performed using a sweep test method and include frequencies specified for cable. A test report shall be available electronically, at no additional cost, for a minimum of five (5) years from the date of manufacture. The test report shall include the reel number, the date of the test, the Lot number, and test results for Return Loss (RL), Insertion Loss (Attenuation), Pair-to-Pair NEXT, and Power Sum NEXT Pair-to-Pair ELFEXT and Power Sum ELFEXT. The test report shall show the "Worst Case Margin" for the listed transmission characteristics.
5. Test results: Test results shall be automatically evaluated by equipment, using most up-to-date criteria from TIA/EIA-568-B standards and all other applicable standards specified in Appendix 1: Codes, Standards, and Informative References, and result shown as pass/fail. Test results shall be printed directly from test unit or from a download file using an application from test equipment manufacturer. The printed test results shall include all tests performed, expected test result and actual test result achieved.
6. Test reports: Test reports for all factory testing and field test reports for copper cabling installation shall be submitted to MCC's CIT representative and manufacturer prior to commissioning voice and data system and final contract payment. Refer to Submittals in this Section.

C. Optical Fiber Cable Testing
   1. General: Optical fiber cabling shall be tested and certified after installation as described below and as required for cable manufacturer's warranty. Fiber testing shall be performed on all fibers in completed end to end system. Testing shall consist of a bi-directional end to end test in accordance with applicable standards in 27 02 20.20, or a bi-directional end to end test performed by EIA/TIA-455-53A and all other applicable standards in 27 02 20.20. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode type glass and 1310 and 1550 nanometers for single-mode type glass. These tests shall also include continuity checking of each fiber. For spans greater than 90 meters, each tested span must test to a value less than or equal to value determined by calculating a link loss budget. For horizontal spans less than or equal to 90 meters, each tested span must be less than or equal to 2.0 decibels. The insertion loss for each mated optical fiber connector pair shall not exceed 0.40 decibels.

2. Pre-installation testing: Test all optical fiber cable for all fibers prior to installation of cable.
3. Performance testing: Where links are combined to complete a circuit between devices, Contractor shall test each link from end to end to ensure performance of system. Only a basic link test is required. Contractor can optionally install patch cords to complete circuit and then test entire channel. The test method shall be same used for test described above. The values for calculating loss shall be those defined in applicable TIA/EIA standards in Appendix 1: Codes, Standards, and Informative References.
4. Attenuation testing: Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach test equipment to cable plant. The light source shall be left in place after calibration and power meter moved to far end to take measurements.
5. Loss budget: Fiber links shall have a maximum loss of:
6. (Allowable cable loss by kilometer) × (kilometers of fiber in link) + (0.2 decibels) × (number of connectors) = maximum allowable loss or (Allowable cable loss per kilometer) x (length of cable in kilometers) + (0.4 dB x number of mated connectors) + (0.3 dB x number of splices) = maximum allowable loss
7. Link loss: A mated connector to connector interface shall be considered a single connector. Loss numbers for installed link shall be calculated by taking sum of bi-directional measurements and dividing that sum by two. All links not meeting requirements of standard shall be brought into compliance by Contractor, at no additional cost to MCC.
8. After-installation testing: Test all optical fiber cable for all fibers after installation of cable.
9. Documentation: Following final documentation shall be submitted to Construction Manager prior to commissioning data system and final contract payment according to Submittals in this section.
    a. Test results: Test results shall be automatically evaluated by equipment, using most up-to-date criteria from all applicable standards specified in 27 02 20.20 and result shown as pass/fail. Test results shall be printed directly from test unit or from a download file using an application from test equipment manufacturer. The printed test results shall include all tests performed, expected test result and actual test result achieved.
    b. End-to-end loss data
    c. As installed diagrams

D. Test Documentation
1. Provide test documentation in 3-ring binders within 2 weeks after completion of project testing. Binders shall be clearly marked on outside front cover and spine with words *Test Results*, project name, and date of completion (month and year). Major heading tabs, *Horizontal* and *Backbone*, shall divide binder. Each major heading shall be further sectioned by test type. Within horizontal and backbone sections, divide by tabs scanner test results by category, optical fiber attenuation test results, and continuity test results. Present test data within each section in sequence listed in administration records. Provide test equipment by name, manufacturer, model number and last calibration date at the end of document. Unless manufacturer specifies more frequent calibration cycle, annual calibration cycle shall be required on all test equipment used for this installation. Test document shall detail test method used and specific settings of equipment during test. Scanner tests shall be printed on 8 1/2 by 11 inches. Hand written test results (attenuation results and continuity results) shall be documented on a suitable test form. When repairs and re-tests are performed, note problem found and corrective action taken, and collocate in binder both failed and passed test data.

Appendix A – Approved Product List

Division 27 Reference	Category / Sub Category	CommScope Part Type / Part #
27 11 19.16	Category 6 Augmented () Patch Panel	X10D M2000 modular patch panel
27 11 19.16	Flat 1U or 2U	M2000-24 or 48
27 11 19.16	Angled 1U or 2U	M2000A-24 or 48
27 11 19.18	Category 6 Patch Panel	1100GS3 GigaSPEED XL Modular Patch Panel
27 11 19.18	Flat 1U or 2U	1100GS3-24 or 48
27 11 19.18	Angled 1U or 2U	1100AGS3-24 or 48
27 11 19.20	Category Patch Panels	1100PS PowerSUM
27 11 19.20	Flat 1U or 2U	1100PSCAT-24 or 48
27 11 19.20	Angled 1U or 2U	1100PSCAT-24 or 48 Angled
27 11 19.22	Category /Class EA High Density Reverse Patching System	VisiPatch 360
27 11 19.24	Category 6/Class E High-Density Reverse Patch Panel System	VisiPATCH 110UB system
27 11 19.30	Multimedia Patching Systems	UMP
27 11 19.30	Category jacks	MGS500
27 11 19.30	Category 6 jacks	MGS400
27 11 19.30	Category Jacks	MPS100E
27 11 19.30	Fiber Optic jacks	
27 11 19.30.C	Universal Modular Patch Panel	M1000P5 MultiMAX patch panel
27 11 19.30.C.3	Universal Modular Patch Panel	FlexiMAX
27 11 19.30.C.5	CATV Patch Panel	384A
27 11 19.30.C.8	CATV Adapters	384A
27 11 19.30.D	S-Video Adapters	M81-SVHS:
27 11 19 30.E	RCA Video Adapters	M81-RCA
27 11 19 30.F	Coaxial Cable Adapters	M81C and M81BNC
27 13 13.09	DS3/4 Interconnect Coax Cable	734C1
27 13 23.10	50 Micron multi mode fiber topic cable	LazrSPEED 550/300/150
27 13 23.12	50 Micron patch Cords	LazrSPEED 550/300/150
27 13 23.15	62.5 Micron multi mode fiber topic cable	OptiSPEED multimode optical fiber
27 13 23.17	62.5 Micron patch Cords	OptiSPEED Patch Cord/Pigtail Assemblies
27 13 23.20	8.3 Micron single mode fiber optic cable	TeraSPEED
27 13 23.25	8.3 micron single mode Optical fiber cords and pigtails	TereSPEED
27 13 23.30	Composite Multimode singlemode Optical Fiber Cable	
27 13 23.50	High Density Pre-terminated Optical Patching System	InstaPATCH
27 13 23.50.B.1	Pre-terminated 12 port LC Module	DM2-12LC-LS/SM Module
27 13 23.50.B.2	Pre-terminated 24 port LC Module	DM2-24 LC-LS/SM Module
27 13 23.50.B.1	Pre-terminated SC Module	DM2-12SC-LS/SM Module
27 13 23.50.B.1	Pre-terminated ST Module	DM2-12ST-LS/SM Module

Division 27 Reference	Category / Sub Category	CommScope Part Type / Part #
27 13 23.50.B.1	Pre-terminated MPO Module	DM-MPO Module
27 13 23.50.C.1	High Capacity Modular Shelf	InstaPATCH MS-4U Shelf
27 13 23.50.C.2	Low Profile Modular Shelf	InstaPATCH MS-1U Shelf
27 13 23.50.C.3	Low Profile Modular Shelf	InstaPATCH MP-1U Shelf
27 13 23.50.C.4	Low Profile High Density Modular Shelf	InstaPATCH DS2 pre-terminated shelf
27 13 23.50.D	Pre-Terminated Cables and Cords	InstaPATCH IPR and IPD
27 13 23.70	Fiber Optic PatchPanels, modules and shelves	600 and 1000G2
27 13 23.90	Fiber optic connector and adapters	P1/P6/P2 optical fiber connectors for LC/SC/ST styles
27 15 13.16.C.1	Category 6 Augmented ()/Class EA non-plenum rated cable	1091 GigaSPEED X10D cable
27 15 13.16.C.2	Category 6 Augmented ()/Class EA plenum rated cable	2091 GigaSPEED X10D cable
27 15 13.16.C.3	Category 6 Augmented ()/Class EA LSZH rated cable	3091 GigaSPEED X10D cable
27 15 13.18.C.1	Category 6/Class E non-plenum rated cable	1071E GigaSPEED XL cable
27 15 13.18.C.2	Category 6/Class E plenum rated cable	2071E GigaSPEED XL cable
27 15 13.18.C.3	Category 6/Class E LSZH rated cable	3071E GigaSPEED XL cable
27 15 13.18.C.4	Category 6/Class E LC cable	4070 GigaSPEED cable
27 15 13.18.C.5	OSP Rated Cable	1571 Cable
27 15 13.20.C.1	Category non-plenum rated cable	1061 PowerSUM cable
27 15 13.20.C.2	Category plenum rated cable	2061 PowerSUM cable
27 15 13.20.C.3	Category LSZH rated cable	3061 PowerSUM cable
27 15 13.20.C.4	Category LC cable	4061 PowerSUM cable
27 15 13.20.C.5	OSP Rated Cable	PowerSUM Cable
27 15 23.10	50 Micron multi mode fiber topic cable	LazrSPEED 550/300/150
27 15 23.15	62.5 Micron multi mode fiber topic cable	OptiSPEED multimode optical fiber
27 15 43.16	Category 6 Augmented ()/Class EA Outlets	MGS500
27 15 43.18	Category 6/Class E Outlets	MGS400
27 15 43.20	Category /Class D Outlets	MPS100E
27 16 19.16	Category 6 Augmented ()/Class EA Cords	GigaSPEED X10D patch cord
27 16 19.18	Category 6 /Class E Patch Cords	GS8E GigaSPEED XL patch cord

END OF SECTION 27 1500

SECTION 27 5313
IP CLOCK 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 work of this section.
B. BICSI Communications Distribution Methods Manual (TDMM), Eleventh Edition.

1.2 SUMMARY

A. This Section specifies materials and accessories for IP clock system.
B. Related Sections:
   1. Section 27 0500 – Communications General Requirements
   2. Section 27 1500 - Communications Horizontal Cabling.

1.3 REFERENCES

A. Federal Communications Division (FCC) Part 15 - Code of Federal Regulations.
B. IEEE 802.3af, Standard for Information Technology - Telecommunications and Information Exchange Between Systems.
C. NFPA 70-2014, National Electrical Code
D. Underwriter's Laboratories (UL)

1.4 COORDINATION

A. Coordinate work of this Section with communications and electronics work and with work of other trades for proper time and sequence to avoid construction delays.

1.5 SUBMITTALS

A. Product Data: Submit product data including manufacturer's literature for clock system materials and accessories, indicating compliance with specified requirements and material characteristics.
   1. Submit list on clock system manufacturer's letterhead of materials and accessories to be incorporated into Work.

2. Include product name.
3. Include preparation instructions and recommendations, installation methods, and storage and handling requirements.
4. Include contact information for manufacturer and their representative for this Project.

B. Operation and Maintenance Data: Supply maintenance data for clock system for incorporation into manual. In addition to items specified in Division 1, include the following:
1. List materials used in clock system work.
2. Warranty: Submit warranty documents specified.
3. Excel spreadsheet with a list of each clock's MAC address and location.

1.6 QUALITY ASSURANCE

A. Communications and Electronics Subcontractor Quality Assurance:
1. Work experience of 3 years minimum with work similar to work of this Section.
2. Manufacturer's authorization to perform work of this section.

1.7 DELIVERY STORAGE AND HANDLING

A. Delivery and Acceptance Requirements:
1. Deliver material in accordance with Division 01.
2. Deliver materials and accessories in clock system manufacture's original packaging with identification labels intact and to suit project.
3. Ensure clock system materials are not exposed to moisture during delivery.
4. Replace damaged clock system materials.

B. Storage and Handling Requirements: Store materials off ground in dry location and protected from exposure to fumes and harmful weather conditions and at temperature conditions recommended by manufacturer.
1. Store in original packaging until installed.

1.8 WARRANTY

A. Project Warranty: Refer to Contract Conditions for project warranty provisions.
B. Manufacturer's warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to and not intended to limit other rights Owner may have under Contract Conditions.
C. Warranty period: Two years commencing on Date of Purchase.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. American Time Integrated Solutions

2.2 SYSTEM REQUIREMENTS

A. Ensure clock system components are designed to operate as part of complete system and include "fail-proof" design to ensure power interruption does not cause system failure.
B. Ensure system can work in conjunction with existing wiring.
C. Ensure system synchronizes all clocks and devices to each other.
D. Ensure system operates utilizing Power over Ethernet to IEEE 802.3af.
E. Ensure system works with monitoring software for system controls from one location and including options as follow:
1. Mark clocks as priority for quick viewing;
2. Uploading and downloading configuration capabilities;
3. Sending numeric messages to digital clocks;
4. Sending countdown functions to digital clocks;
5. Sending alphanumeric messages to digital clocks;

6. Displaying which clocks are not receiving (S)NTP time.

F. Ensure system monitor is run on PC on same network as IP (PoE) system.
   1. Server installation is not required.
G. Ensure system is capable of operating without physical servers and software.
H. Ensure each clock in system has built-in web interface for programming.
I. Ensure system is capable of programming clocks immediately upon receipt of signal.
   1. Analog and digital clocks automatically correct themselves on receipt of signal.
   2. Include built-in closed-loop system in analog clocks capable of allowing clocks to detect position of hands and bring clocks to correct time even if clocks are manually altered.
   3. Ensure analog clocks have diagnostic function capable of allowing user to view how long since clock received a digital signal.
   4. Ensure analog clocks are capable of functional tests of electronics and gears.
J. Ensure each individual product is bench tested at manufacturer's facility.
   1. Random testing is unacceptable.

2.3 SECONDARY CLOCKS

A. Analog Clocks: To UL and cUL, designed for IP (PoE) system with fully automatic plug and play capability.
B. Ensure secondary clock is capable of receiving NTP and DHCP (Dynamic Host Configuration Protocol) protocol through CAT5 or CAT6:
   1. Clock display: 12 hour white face with black numbers.
   2. Sizes:
      a) Round 12 inch diameter (13.25 inches actual size)
      b) Round 10 inch diameter (11.25 inches actual size)
   3. Convex Glass Crystal
   4. Enclosure made of steel with a durable powder coated finish.
   5. Enable time indication, synchronization, and correction over an IP-based LAN/WAN allowing locating a clock display anywhere on the network.
   6. Clock synchronization can be programmed to sync with any NTP (Network Time Protocol) server.
   7. Power: 1W via a Power over Ethernet (PoE) switch meeting the 802.3af specification.
   8. Clock shall be programmed to use DHCP for its IP address.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ensure all clock system components are installed by single communications and electronics subcontractor.
B. Install IP communication clock system in accordance with manufacturer's written recommendations and in accordance with NFPA 70.
C. Integrate clock system with Owner's electrical and communications network.
D. Install cabling in accordance with Section 27 1500 - Communications Horizontal Cabling.
E. Conceal wiring except in unfinished spaces and as approved in writing by Consultant.
F. Install clocks only after painting and other finish work is completed in each room.
G. Install clocks and other devices square and plumb.

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. At completion of installation and before final acceptance, turn on equipment and ensure equipment is operating properly, and clock system devices and components are functioning.
   2. Evaluate and test each device in clock system on room-by-room basis using factory-trained technicians.

a. Fix or replace devices which fail test or are functioning incorrectly.
b. Submit evaluation and report showing results of room-by-room tests and overall system compliance within 3 days of testing being carried out.

3.3 CLEANING

A. Progress Cleaning: Perform cleanup as work progresses.
   1. Leave work area clean at end of each day.
B. Final Cleaning: Upon completion, remove surplus materials, rubbish, tools, and equipment.

3.4 DEMONSTRATION AND TRAINING

A. Arrange system demonstration and training session for Owner's operation and maintenance personnel.
   1. Allow Owner and Consultant 7 days minimum advance notice before training session.
B. Break down system demonstration and training session into logical segments for Owner's operations and maintenance personnel.
C. Train Owner's maintenance personnel in procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of clock system.

3.5 PROTECTION

A. Protect installed products and accessories from damage during construction.
B. Repair damage to adjacent materials caused by clock system installation.

END OF SECTION 27 5313

SECTION 28 2000
VIDEO SURVEILLANCE

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 a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, with its associated equipment.
B. Related Requirements:
   1. Section 27 1500 – "Communications Horizontal Cabling."

1.3 DEFINITIONS

A. IP: Internet protocol.
B. LAN: Local area network.
C. MPEG: Moving picture experts group.
D. PTZ: Pan-tilt-zoom.
E. WAN: Wide area network.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
B. Product Warranty: Sample of warranty.
C. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.5 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Video-signal format shall comply with H.264 compression standard.

2.2 CAMERAS

A. IP Camera:
   1. Manufacturer: Pelco IMM12027-1I
   2. 270 degree, stitched and blended panoramic views.
   3. Vandal-Resistant, In-Ceiling or Pendant
   4. Input Power: PoE+ (IEEE 802.3at, Class 4)
   5. Resolution: 12 MP (4x), 2048 x 1536 x 4
   6. Signal-to-Noise Ratio: Not less than 50 dB
   7. Sensitivity: f/2.5 F-Stop, 0.3 lux Color, 0.2 lux Mono
   8. Wide Dynamic Range
   9. Audio: Streaming Bidirectional
   10. Rated for operating temperature of 14°F to 122°F.
   11. Finish: White

2.3 LENSES

A. Description: Built-in, varifocal, motorized autofocus, 3-9mm focal length, DC drive P-iris lens.

2.4 CAMERA-SUPPORTING EQUIPMENT

A. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.
B. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions.

2.5 IP VIDEO SYSTEMS

A. Existing Pelco system.

2.6 SIGNAL TRANSMISSION COMPONENTS

A. Cable: Comply with requirements in Section 27 1500 "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
B. Examine roughing-in for LAN, WAN, and IP network before device installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

A. Wiring Method: Install cables in raceways unless otherwise indicated.
   1. Except raceways are not required in accessible indoor ceiling spaces and attics.
   2. Conceal raceways and wiring except in unfinished spaces.
B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
C. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. 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-486B.
D. For communication wiring, comply with the following:
   1. Section 27 1500 "Communications Horizontal Cabling."

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.
B. Install cameras with 84-inch- minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
C. Provide in-ceiling cameras for locations with ceiling. Provide pendant cameras for areas exposed to structure.
D. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.
E. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

3.4 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 inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. 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.
D. Tests and Inspections:
   1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
   2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
      a. Prepare equipment list described in "Submittals" Article.
      b. Verify operation of auto-iris lenses.
      c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
      d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
      e. Set and name all preset positions; consult Owner's personnel.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Video surveillance system will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.

3.5 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 during other-than-normal occupancy hours for this purpose. 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's use of video surveillance system.
5. Provide a written report of adjustments and recommendations.

3.6 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.

END OF SECTION 28 2000

SECTION 28 3100
FIRE ALARM

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.

B. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements.”

1.2 SUMMARY

A. This Section includes design and installation of a new fire alarm system utilizing some existing devices.

B. Related Sections include the following:

1. Division 8 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm 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, analog-addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only.
   1. Interface with existing fire alarm system.
B. Fire alarm system shall consist of the following:
   1. New fire alarm control panel.
   2. Relocation of existing fire alarm devices.
   3. System smoke detection above all control panels and notification appliance power supply panels.
   4. System smoke detection as required at air handling units, smoke rated transfer openings, and smoke damper locations.
   5. All flow and tamper switches to monitor fire sprinkler and standpipe systems and report appropriate alarm and supervisory signals.
   6. Manual fire alarm boxes at each building exit (prior to entering exit stairwells at each floor).
   7. Audible and visual notification appliances in all public and common areas of the building.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.
B. Comply with NFPA 70.
C. A complete functional system meeting the requirements of this specification, including alarm initiating devices and notification appliances at locations and ratings to meet the requirements of the Authorities Having Jurisdiction and all applicable codes shall be provided.
D. Coordinate and avoid conflicts with casework, markerboards, feature walls, and other areas where fire alarm devices would interfere with furnishings, finishes, etc.
E. Fire alarm system vendor shall provide sound pressure level calculations demonstrating compliance with NFPA 72 and establish quantities and tap settings of audible devices.
F. No additional charges for work or equipment required for a code compliant system approved by the Authority Having Jurisdiction will be allowed.
G. Obtain and refer to mechanical drawings for smoke damper locations, smoke rated transfer openings, and air handling equipment CFM's. Provide smoke detection as required by applicable codes.
H. Premises protection includes Building Use Group B.
   1. Refer to drawings for complete code analysis including construction type, use groups, special occupancy types, rated walls, smoke barriers and partitions, etc.
I. System functional performance shall be as indicated on the fire alarm matrix on the drawings.

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: Include address descriptions that will appear on the FACP display.
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: Provide battery sizing calculations. Battery size shall be a minimum of 125% of the calculated requirement.
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. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
9. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show device layout, size and route of cable and conduits.

C. Field quality-control test reports.
D. 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.
E. 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 Architect for review.
F. Documentation:
   1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and Authorities Having Jurisdiction.
   2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
      a. Hard copies on paper to Owner, Architect, and Authorities Having Jurisdiction.
      b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
B. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level II.
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.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Fire Alarm Service: Do not interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions

and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of fire alarm service.
2. Do not proceed with interruption of fire alarm service without Construction Manager's written permission.

1.9 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of the new fire alarm system, remove existing disconnected fire alarm equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FACP and Equipment:
   a. National Time & Signal.

2.2 EXISTING FIRE ALARM SYSTEM

A. Compatibility with Existing Equipment: Fire alarm system and components shall operate as an extension of an existing system.

2.3 FACP

A. General Description:

1. Modular, power-limited design with electronic modules, UL 864, 9th edition, listed.
2. 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.
3. Addressable control circuits for operation of mechanical equipment.
4. Mounting: Surface.

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, 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 between control panels: NFPA 72, Class A, Style 7
2. Signaling Line Circuits from control panel to devices: NFPA 72, Class B, Style 4.
   a. System Layout: Install no more than 50 addressable devices on each signaling line circuit.
3. Notification-Appliance Circuits: NFPA 72, Class B, Style Y.
4. Actuation of alarm notification appliances, annunciation, and actuation of suppression systems shall occur within 10 seconds after the activation of an initiating device.

5. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

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.
   4. Sound general alarm if the alarm is verified.
   5. Cancel FACP indication and system reset if the alarm is not verified.

E. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.

F. 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.

G. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP 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.

H. 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.

I. 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, and make a print-out of the final adjusted values on the system printer.

J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory and digital alarm communicator transmitter 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.
   2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."

K. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
   1. Battery and Charger Capacity: Comply with NFPA 72.

L. Surge Protection:
   1. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

M. 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.

2.4 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. Single-action mechanism, 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.

2.5 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 and power-on 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. Photoelectric Smoke Detectors:
   1. Sensor: LED or infrared light source with matching silicon-cell receiver.
   2. Detector Sensitivity: Between 2.5 and 3.5 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.
      a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.
   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 and power-on status. Provide remote status and alarm indicator and test station where required.
   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: Provide two (2) sets of contacts rated to interrupt fan motor-control circuit.

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. Finishes:
      a. Wall mounted appliances: Provide white finish with red lettering.
      b. Ceiling Mounted Appliances: Provide white finish.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn.

C. 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, 30, 60, 75, 110, 135, 185 candela as required to meet NFPA 72 requirements.
   2. Strobe Leads: Factory connected to screw terminals.

2.7 REMOTE STATUS AND ALARM INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 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.

2.9 ADDRESSABLE CONTROL MODULE

A. Provide for integration of auxiliary control functions into the analog signaling circuit. Intelligent analog signaling circuit control module shall have the following capabilities:
   1. Communication interaction with the analog signaling circuit having the capability of initiating a control function to an auxiliary device based on a specified event.
   2. Provide NO/NC contact pairs rated at 2 amps 120 VAC or 24 VDC.

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. Fire alarm wire and cable shall be as specified by the system manufacturer including conductor gage, conductor quantity, conductor twists and shielding required to meet NFPA class and style performance specified.

C. Signaling Line Circuits and other power limited fire alarm circuits (PLFA):
   1. PLFA circuits installed in conduit or raceway: U.L. Listed type FPL
   2. PLFA circuit cable installed exposed in accessible ceiling spaces, risers and elsewhere: U.L. Listed type FPLP.
   3. PLFA circuits installed where 2 hr rating is required to meet the survivability requirements of NFPA 72: Circuit integrity cable, NFPA 70 Article 760,

Classification CI, UL listed as Type FPL, FPLR or FPLP as required, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

D. Non-Power-Limited Fire Alarm Circuits (NPLFA):
   1. NPLFA circuits installed in conduit: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
      a. Low-Voltage Circuits: No. 16 AWG, minimum.
      b. Line-Voltage Circuits: No. 12 AWG, minimum.
   2. NPLFA circuit cable installed exposed in ceiling spaces, risers and elsewhere: Multi-conductor cable, U.L Listed type NPLFP.
   3. NPLFA circuits installed where 2 hr rating is required to meet the survivability requirements of NFPA 72: Multi-conductor cable, U.L Listed type NPLFP-CI

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.
   1. Connect existing equipment to the new control panel.
   2. Connect new equipment to the existing monitoring equipment at the Supervising Station.
   3. Expand, modify, and supplement the existing control and monitoring equipment as necessary to extend the existing control and monitoring functions to the new points.
   4. New components shall be capable of merging with the existing configuration without degrading the performance of either system.

B. Smoke or Heat Detector Spacing:
   1. Smooth ceiling spacing shall not exceed 30 feet
   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.

C. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

D. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct.

E. Remote Status and Alarm Indicators: Install near each smoke detector, each duct detector and each sprinkler water-flow switch and valve-tamper switch that is above 10’-0” aff, concealed, or otherwise not readily visible from normal viewing position. Coordinate exact locations with local fire department and submit to architect for approval.

F. Audible Alarm Notification Appliances: Install wall mounted appliances not less than 6 inches below the ceiling.

G. Visible Alarm Notification Appliances: Install wall mounted appliances at 96” AFF or 6 inches below the ceiling, whichever is less.

H. Coordinate ceiling mounted appliances with reflected ceiling plans. Do not install visual appliances where pendant mounted or suspended lighting fixtures will obstruct intended viewing angles.

I. Provide ceiling mounted notification appliances in all spaces unless the ceiling type prohibits installation. Ceiling mounted devices are the preference for all spaces, where possible.

J. Install wall mounted and ceiling mounted notification appliances flush on recessed j-box or back box for all new work and on existing gyp-board partition walls.

K. Install notification appliances on existing CMU walls on surface back-boxes matching the dimensions and finish of the notification appliance.

L. Device Location-Indicating Lights: Locate in public space near the device they monitor.
M. FACP: Surface mounted with tops of cabinets not more than 72 inches above the finished floor.
    1. Install smoke detector above panel. Install on ceiling for ceilings under 10 ft. For ceilings above 10', wall mount a smoke detector listed for releasing service 10' AFF or 1' below finished ceiling (whichever is lower).
N. Provide all 120V branch circuits for all control panels, sub panels, and ancillary equipment required for the system.

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."
    1. 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 Method:
    1. In accessible ceilings, install plenum rated fire alarm cabling.
    2. In inaccessible ceilings, install fire alarm cabling in conduit. Provide red junction boxes.
    3. In exposed construction finished spaces, install fire alarm cabling in unfinished conduit. Provide red junction boxes.
    4. In exposed construction unfinished spaces, install fire alarm cabling in red conduit. Provide red junction boxes.
    5. Drops to surface mounted devices shall be installed in surface raceway. No exposed cable shall be visible below the ceiling. Where the ceiling is exposed, route the raceway up to the structural member that will conceal the cable.
    6. Drops to devices recessed in partition walls shall be installed in conduit.
    7. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
D. 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.
E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
F. 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.
G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section “Electrical Identification."
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. 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.
      a. Include the existing system in tests and inspections.
   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 PROGRAMMING

A. Coordinate final address descriptions for alarm, supervisory and trouble indication that appear on FACP and Annunciator displays with the Owners representative. This shall include all room names, room numbers, building areas for fire protection zones, exit door descriptions and similar items. This coordination shall take place and be implemented in the programming prior to Demonstration and Owner Training.

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. 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. Semiannual Test and Inspection: Six months 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, and semiannual periods. Use forms developed for initial tests and inspections.
D. 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.

3.8 WARRANTY

A. All newly installed equipment shall be warranted by the contractor for a period of one year following acceptance. The warranty shall include parts, labor, prompt field service, pickup and delivery.

3.9 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.

END OF SECTION 28 3100

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SECTION 31 1000
SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Protecting existing trees and vegetation to remain.
B. Topsoil stripping.
C. Removing above-grade site improvements.

1.3 RELATED SECTIONS

A. Division 1 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and environmental protection measures during site operations.
B. Division 31 Section "Earthwork" for soil materials, excavating, backfilling, and site grading.

1.4 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer 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 2 inches (50 mm) in diameter; and free of weeds, roots, and other deleterious materials.

1.5 MATERIALS OWNERSHIP

A. Except for materials indicated to be stockpiled or to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from the site.

1.6 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

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 authorities having jurisdiction.
B. Improvements on Adjoining Property: Authority for performing indicated removal and alteration work on property adjoining Owner's property will be obtained by Owner before award of Contract.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
D. Notify utility locator service for area where Project is located before site clearing.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earthwork."
   1. Obtain approved soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.
B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
C. Locate and clearly flag trees and vegetation to remain or to be relocated.
D. Protect existing site improvements to remain from damage during construction
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 UTILITIES

A. 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 not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.

3.3 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
   3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches (450 mm) below exposed subgrade.
   4. Use only hand methods for grubbing within drip line of remaining trees.
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 8-inch (200-mm) loose depth, and compact each layer to a density equal to adjacent original ground.

3.4 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
   1. Strip surface soil of unsuitable topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water.
   1. Limit height of topsoil stockpiles to 72 inches (1800 mm).
   2. Do not stockpile topsoil within drip line of remaining trees.
   3. Stockpile surplus topsoil where directed by Owner.

3.5 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as 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 length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.6 DISPOSAL

A. Disposal: Remove unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

B. Surplus satisfactory soil shall be distributed onsite as directed by Owner. Seed as required to stabilize.

END OF SECTION 31 1000

SECTION 31 2000
EARTHWORK

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 SECTION INCLUDES

A. Preparing sub-grades for slabs-on-grade, retaining walls, walks and pavements.

1.3 RELATED SECTIONS

A. Division 1 Section “Construction Facilities and Temporary Controls.”
B. Division 26 Sections for excavating and backfilling buried mechanical and electrical utilities and buried utility structures.
C. Division 2 Section “Selective Structure Demolition.”

1.4 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 concrete walks, concrete pavements 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.
    1. Additional Excavation: Excavation below subgrade elevations as directed by the Construction Manager with the approval of the Owner. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
    2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by the Construction Manager with the approval of the Owner, shall be without additional compensation.
G. Fill: Soil materials used to raise existing grades.
H. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material ¾ cu. Yd. (0.57 cu. M) or more in volume that when tested by an independent geotechnical

testing agency, according to ASTM D 1586, exceeds a standard penetration resistance of 100 blows/2 inches (97 blows/50 mm).

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. Sub-base Course: Layer placed between the sub-grade and the base course of a concrete walk, concrete pavement or asphalt paving when specified.

K. Sub-grade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below sub-base or base if no sub-base specified, drainage fill, or topsoil materials.

L. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.5 SUBMITTALS

A. Material Test Reports: From a qualified testing agency 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.
2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.
3. Laboratory compaction curve according to ASTM D 1557 for each on-site or borrow soil material proposed for fill and backfill.

1.6 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: 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. Pre-excavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section “Project Meetings.”

C. Excavation team shall be established and experienced with a minimum of 5 years experience constructing athletic fields.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner and Architect not less than three days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect’s written permission.
3. 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 (75 mm) 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. Sub-base: 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 (38-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

F. Base: MDOT designated 21AA limestone aggregate.

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 (38-mm) sieve and not more than 12 percent passing a no. 200 (0.075-mm) 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 (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

I. Drainage Fill: Washed, narrowly graded mixture of crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (38-mm) sieve and 0 to 5 percent passing a no. 8 (2.36-mm) 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 (25-mm) sieve and 0 to 5 percent passing a no. 4 (4.75-mm) sieve.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

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 sub-grades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion-control measures to prevent 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 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared sub-grades, and from flooding Project site and surrounding area.
B. Protect sub-grades 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.
    2. Install a dewatering system to keep sub-grades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives

3.4 EXCAVATION, GENERAL

A. Classified Excavation: Excavation to sub-grade elevations classified as earth and rock. Rock excavation will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.
    1. Earth excavation includes excavating pavements and obstructions visible on the surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
        a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation
    2. Rock excavation includes removal and disposal of rock.
        a. Do not excavate rock until it has been classified and cross-sectioned by Architect.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). 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.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements per recommendations in Geotechnical Investigation.

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 a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
    1. Clearance: 12 inches (300 mm) on each side of pipe or conduit.
C. Trench Bottoms: Excavate trenches 4 inches (100 mm) deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
    1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

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.

3.9 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
    1. Construction below finish grade.
    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 (450 mm) of bottom of footings; fill with concrete to elevation of bottom of footings.
C. Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of an access drive. After installing and testing, completely encase piping or conduit in a

minimum of 4 inches (100 mm) of concrete before backfilling or placing an access drive subbase.

D. Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) 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.
E. Coordinate backfilling with utilities testing.
F. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.
G. Place and compact final backfill of satisfactory soil material to final subgrade.

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, planted areas and natural turf areas, use satisfactory soil material expanded to include ASTM D2487 Soil Classification Groups GC, SC, ML and CL provided they are maintained within 2% of optimum moisture content at time of compaction. Topsoil layer thickness under grass and planted areas may vary beyond a 4” minimum provided it is placed and compacted in 6” thick layers. Topsoil layer thickness under natural turf field areas may vary provided it is placed and compacted in 6” thick layers maintaining a uniform total thickness across the individual turf field areas.
    2. Under walks, pavement areas and artificial turf field areas 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 6 inches (200 mm) in loose depth for material compacted by heavy compaction equipment,

and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill 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 1557.

1. Under Structures, building slabs, walkways, steps and pavements, scarify and recompact top twelve inches (12”) of subgrade and each layer of backfill or fill soil material at ninety-five percent (95%) of maximum density.
2. Under grass, planted areas and natural turf areas: Compact top six inches (6") of subgrade and each layer of backfill or fill soil material at eighty-five percent (85%) of maximum density.

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 trasition 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 (25 mm).
2. Walks: Plus or minus 1 inch (25 mm).
3. Pavements: Plus or minus ½ inch (13 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of ½ inch (13 mm) when tested with a 10-foot (3-m) straightedge.

D. Aggregate Drainage Layer: See Specification (32 1123) for tolerances

E. Finish Grading:

a. Sub-Soil Preparation:

1. Fine grade sub-soil systematically to eliminate uneven areas and low spots. Remove debris, roots, branches, stones, etc., in excess of two inches (2") in size. Remove sub-soil which has been contaminated with petroleum products.
2. Cultivate sub-grade to a depth of six inches (6") where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil.
3. Compact sub-soil at the following percentages to a depth of 12 inches: a 85% Modified Proctor where topsoil is to be placed.

3.15 SUBBASE AND BASE COURSES

A. Where specified, install separation fabric on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
B. Under pavements and walks, place base course on prepared subgrade and as follows:
    1. Place base course material over subbase course where specified.
    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 (150 mm) or less, place materials in a single layer.
    5. When thickness of compacted subbase or base course exceeds 6 inches (150 mm), place materials in equal layers, with no layer more than 6 inches (150 mm) thick or less than 30 inches (75 mm) thick when compacted.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
B. Allow testing agency to 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 Architect.
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 and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of wall length, but no fewer than two tests.
    2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet (30 m) 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 each 150 feet (46 m) 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.

3.17 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; 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.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 31 2000

SECTION 32 1313
CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Concrete paving for sidewalks.
B. Aggregate base course per Division 31, Earthwork.

1.3 REFERENCES

A. ACI 301 - Specifications for Structural Concrete for Buildings.
B. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
C. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.
D. ANSI/ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
E. ANSI/ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.
F. ANSI/ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
G. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
H. ASTM C33 - Concrete Aggregates.
I. ASTM C94 - Ready Mix Concrete.
J. ASTM C150 - Portland Cement
K. ASTM C260 - Air-Entraining Admixtures for Concrete.
L. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
M. ASTM C494 - Chemical Admixtures for Concrete.
N. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.

1.4 PERFORMANCE REQUIREMENTS

A. Paving: Designed for light duty commercial vehicles.
B. All exterior concrete paving shall be air entrained.

1.5 SUBMITTALS

A. Submit under provisions of Division 01.
B. Product Data: Provide data on joint filler, admixtures and curing compounds.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301, requirements of Section 03 3000 and State of Michigan Highway Standards.

B. Obtain cementitious materials from same source throughout.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable standards for paving work on private property.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Form Materials: Conform to ACI 301 and as specified in Section 03 3000.
B. Wood or Steel form material, profiled to suit conditions.
C. Joint Filler: ANSI/ASTM D1751 D1752 pourable type; coordinate with Section 07900.

2.2 REINFORCEMENT

A. Fiber mesh: Sika Fibermesh HP. Micro-reinforcement system. 100 percent virgin homopolymer polypropylene ultra-type multifilament (monofilament) micro-fibers fibers containing no reprocessed olefin materials.
B. Dowels: ASTM A615; 60 ksi yield grade, plain steel, uncoated finish.

2.3 CONCRETE MATERIALS

A. Concrete Materials: As specified in Section 03 3000, and per MDOT.

2.4 ACCESSORIES

A. Curing Materials: Per Section 03 3000, and per MDOT Section 8.24.

2.5 CONCRETE MIX - BY PERFORMANCE CRITERIA

A. Mix and deliver concrete in accordance with ASTM C94, Alternative No. 2, and per MDOT.
B. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94, and per MDOT.
C. Select proportions for normal weight concrete in accordance with ACI 301 Method 1.
D. Provide concrete to the following criteria:
   1. Compressive Strength: 3500 psi @ 28 days.
   2. Slump: 3 to 4 inches.
E. Use accelerating admixtures in cold weather only when approved by Architect-Engineer. Use of admixtures will not relax cold weather placement requirements.
F. Do not use calcium chloride or other corrosive materials.
G. Use set retarding admixtures during hot weather only when approved by Architect-Engineer.

2.6 SOURCE QUALITY CONTROL

A. Provide mix design under provisions of Section 01 4000.
B. Submit proposed mix design to appointed firm for review prior to commencement of work.
C. Tests on cement and aggregates will be performed to ensure conformance with specified requirements.
D. Test samples in accordance with ACI 301.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify base conditions under provisions of Section 01 4000.
B. Verify compacted subgrade and granular base is acceptable and ready to support paving and imposed loads.
C. Verify gradients and elevations of base are correct.

3.2 SUBBASE AND/OR BASE

A. Division 31 - Earthwork, forms the base construction for work of this Section.

3.3 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete. Do not flood.
B. Coat surfaces of manhole, catch basin and other frames with oil to prevent bond with concrete pavement as required.
C. Notify Architect-Engineer minimum 72 hours prior to commencement of concreting operations.

3.4 FORMING

A. Place and secure forms to correct location, dimension, and profile.
B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.5 REINFORCEMENT

A. Place dowels to achieve alignment where mating to existing adjacent slabs.
B. Provide dowelled joints at interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement.

3.6 JOINTS

A. Place expansion and contraction joints at 20 foot intervals or as noted on Drawings. Align curb, gutter, and sidewalk joints.
B. Place joint filler between paving components and building or other appurtenances. Recess top of filler 1/4 inch for pourable sealant placement per Section 07 9200.
C. Provide tooled control joints at intervals shown on Drawings for sidewalks and curbs, or if not shown, equal to the sidewalk width and 8 ft.

maximum. Sawcut joints are not acceptable.

3.7 PLACING CONCRETE

A. Place concrete in accordance with ACI 301 and as specified in Section 03 3000.
B. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
C. Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
D. Place concrete to pattern indicated. Tool contraction joints 3/16 inch wide at an optimum time after finishing. Tool 1/3 into depth of slab.
E. Fill joints with pourable traffic sealant.

3.8 FINISHING

A. Sidewalk Paving: Light broom, radiused to 1/2 inch radius, and troweled joint edges. Broom finish after troweling.
B. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions and Section 03300.

3.9 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 01.
B. Testing firm will take cylinders and perform slump and air entrainment tests in accordance with ACI 301, and per MDOT.
C. Three concrete test cylinders will be taken for every 32 or less cu yds of concrete placed each day.
D. One additional test cylinder will be taken during cold weather and cured on site under same conditions as concrete it represents.
E. One slump test will be taken for each set of test cylinders taken.
F. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.10 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

END OF SECTION 32 1313

SECTION 40 1700
WELDING AND CUTTING GASES 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. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 20 Section "Meters and Gages" for thermometers and pressure gages.

1.2 SUMMARY

A. This Section includes piping for welding and cutting gases including:
   1. Acetylene.
   2. Argon.
   3. Argon/Carbon dioxide mix.
   4. Oxygen.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene plastic.

B. TFE: Tetrafluoroethylene plastic.

C. CGA: Compressed Gas Association.

D. BAS: Building Automation System.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum pressure, unless otherwise indicated:
   1. Welding and Cutting Gas Piping: 125 psig.

1.5 SYSTEMS DESCRIPTIONS

A. Welding and Cutting Gas Piping:
   1. Acetylene Piping: Use the following:
      a. Steel pipe, steel welding fittings, and welded joints, except at threaded or flanged valve and equipment connections.
   2. Argon, Carbon Dioxide, Argon/Carbon Dioxide Mix, and Oxygen Piping: Use the following:
      a. Type K, hard copper tubing, wrought copper pressure fittings, and brazed joints.

B. Drawings indicate valve types to be used for welding and cutting gas piping. If specific valve types are not indicated, the following requirements apply:
   1. Acetylene Piping: Use the following:
      a. Shutoff Valves: Carbon-steel ball valve.
      b. Check Valves NPS 1-1/2 and Smaller: Forged steel.
      c. Check Valves NPS 2 and Larger: Cast iron.
   2. Argon, Carbon Dioxide, Argon/Carbon Dioxide Mix, and Oxygen Piping: Use the following:
      a. Shutoff Valves NPS 3 and Smaller: Copper-alloy ball valve.
      b. Check Valves NPS 3 and Smaller: Bronze.

1.6 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Welding and cutting gas tubing and fittings.
   2. Welding and cutting gas valves.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For welding and cutting gas systems. Include relationship to other services that serve same work area.

1.8 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

1.9 QUALITY ASSURANCE

A. Comply with NFPA 51, Oxygen-fuel Gas System for Welding, Cutting, and Allied Processes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where 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 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M; Schedule 40; Type E or S; Grade B; black.
   1. Fittings:

a. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
b. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
c. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
d. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
e. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
f. Steel Flanges and Flanged Fittings: ASME B16.5.

2.3 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 819, Type K, seamless, drawn-temper, tube that has been factory cleaned, purged, and sealed for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube.
   1. Fittings: Factory cleaned, purged, and bagged for oxygen service according to ASTM B 819 or field cleaned, purged, and bagged as specified in "Preparation" Article in Part 3.
      a. Copper Pressure Fittings: ASME B16.22, wrought-copper solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
      b. Cast-Copper-Alloy Flanges: ASME B16.24, Class 300.
      c. Copper Unions: ASME B16.22 or MSS SP-123.

2.4 JOINING MATERIALS

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.
B. Threaded-Joint Tape: PTFE.
C. Gasket Material: ASME B16.21, nonmetallic, flat, asbestos free, and suitable for service.

2.5 WELDING AND CUTTING GAS SYSTEM VALVES

A. Carbon-Steel Ball Valves: Factory cleaned for service and bagged, MSS SP-72, split-body ball valve rated for 300-psig minimum working pressure; with stainless-steel ball, PTFE or TFE seats, blowout-proof stem, flanged ends, and locking-type handle.
   1. Manufacturers:
      a. Conbraco Industries, Inc., Apollo Ball Valves.
      b. Milwaukee Valve Company.
      c. NIBCO INC.
B. Copper-Alloy Ball Valves: Factory cleaned for oxygen service and bagged. MSS SP-110, 3-piece-body, full-port ball valve rated for 300-psig minimum working pressure; with chrome-plated brass ball, PTFE or TFE seats, blowout-proof stem, threaded or solder-joint ends, and locking-type handle designed for quarter turn between opened and closed positions.
   1. Manufacturers:
      a. Apollo Ball Valves; Conbraco Industries, Inc.
      b. Milwaukee Valve Company.
      c. NIBCO INC.
C. Cast-Iron Check Valves: MSS SP-71, Class 250, iron-body, bronze-trim, swing check valve, with flanged ends. Factory cleaned for service and bagged.
D. Forged Steel Check Valves: Class 800, forged steel body, stainless steel trim, swing check valve, with socket weld ends. Factory cleaned for service and bagged.

E. Bronze Check Valves: Straight-through-pattern, spring-loaded ball check valve; designed for 300-psig minimum working pressure. Factory cleaned for service and bagged.

2.6 TEST GAS

A. Description: Oil-free dry nitrogen complying with CGA P-9, for purging and testing of piping.

2.7 IDENTIFICATION

A. Refer to Division 20 Section "Mechanical Identification" for identification of piping, valves, gages, and specialties.

PART 3 - EXECUTION

3.1 PREPARATION

3.2 PIPING SYSTEM INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping installation.
B. Install pressure gages according to Division 20 Section "Meters and Gages."
C. Install flexible pipe connector at each connection to equipment.
D. Purge welding and cutting gas piping, using oil-free dry nitrogen, after installing piping but before connecting to gages.

3.3 VALVE INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping and valve installation.
B. Install shutoff valve at each connection to and from welding and cutting gas specialties and equipment.
C. Install check valves to maintain correct direction of fluid flow to and from laboratory air and vacuum specialties and equipment.

3.4 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.5 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 20 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. 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 20 Section "Hangers and Supports."
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 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.

A. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4: 60 inches with 3/8-inch rod.
   2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
   3. NPS 3/4: 84 inches with 3/8-inch rod.
   4. NPS 1: 96 inches with 3/8-inch rod.
   5. NPS 1-1/4: 108 inches with 3/8-inch rod.
   6. NPS 1-1/2: 10 feet with 3/8-inch rod.
   7. NPS 2: 11 feet with 3/8-inch rod.

B. Install supports for vertical copper tubing every 10 feet.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to specialties and equipment to allow service and maintenance.

3.7 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for laboratory air and vacuum piping systems. Refer to Division 20 Section "Mechanical Identification" for labeling and identification materials.

B. Captions and Color-Coding: Comply with ASME (ANSI) A13.1 unless otherwise indicated.

3.8 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Provide oil-free dry nitrogen, materials, and equipment required for testing.
      a. Piping Integrity Tests:
         1) Blow Down: Clear piping before connecting service connections or outlets.
         2) Initial Pressure Tests: Subject each piping section to test pressure of 1.5 times system working pressure, but not less than 150 psig, before attaching system components, after installing station outlets with test caps (if supplied) in place, and before concealing piping system. Maintain test until joints are examined for leaks by means of soapy water. Repair leaks with new materials and retest systems.
         3) Purge Tests: Perform heavy intermittent purging of piping and full-flow purging of service connections.
      b. Verification and Final Testing: Activate systems with compressed air at normal operating pressure.
         1) Standing-Pressure Tests: Install assembled system components after testing individual systems as specified above. Subject systems to 24-hour standing-pressure test. Verify that pressure differences comply with required calibration. Repair leaks with new materials and retest systems.
   2. Test and adjust controls and safeties.

END OF SECTION 40 1700

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