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SECTION 033543 POLISHED CONCRETE SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Products and procedures for the installation of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System using a multi-step dry mechanical process and accessories indicated, specified or required to complete system and achieve specified finish:
 - a. DIAMATIC Mechanical Diamond Grinding and Polishing Equipment
 - b. ULTRAFLOOR ARDEX DIAMATIC Concrete Repair and Topping Materials
 - c. ULTRAFLOOR ARDEX DIAMATIC Concrete Treatment Chemicals
2. Products and procedures for the initial and long term maintenance of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System.
3. All equipment, diamond products, concrete repair and topping materials, crack and joint treatments and chemicals are specified by DIAMATIC Management Services, DIAMATIC AND ARDEX.

1.2 SUBMITTALS

- A. Product Data: Submit Manufacturer's technical literature for each product indicated, specified or required. Include manufacturer's technical data, application instructions, recommendations and MSDS.
- B. Installer Qualifications: Data for company, principal personnel, experience, and training. Provide a letter documenting installer's accreditation and certification compliance, as specified under quality assurance.
- C. Test Reports: Provide field quality control sheen gloss reading and static coefficient of friction test results conducted as specified and recorded on floor plan diagram confirming compliance with specified performance criteria.
- D. Warranty: Provide manufacturer's warranty of ULTRAFLOOR System materials, contractor workmanship and finish standards.
- E. Maintenance Data: Provide manufacturer's instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under intended use. These instructions should contain precautions against cleaning products and methods, which may be detrimental to finishes and performance.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: The ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System consists of a process and products engineered and manufactured by ARDEX and DIAMATIC. Any substitutions are not permitted and void warranty.
- B. Installer Qualifications:
 - a. Installer must be experienced and factory-trained in the installation of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System, including the use of DIAMATIC equipment and diamond abrasives, and ARDEX DIAMATIC concrete preparation, joint treatment and chemical hardening and finishing materials.
 - b. Installer must be experienced in performing specified work similar in design, products and scope of this project, with a documented track record of successful, in-service performance and with sufficient production capabilities, facilities and personnel to produce specified work.

- c. A factory-trained, competent supervisor must be maintained on site during all times during which specified work is performed.
 - d. Installer must provide written documentation from the manufacturer confirming the Installer's accreditation and training from both ARDEX and DIAMATIC to be at the ELITE/CHOICE level of accreditation on installation of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System and related equipment and processes. Contact ULTRAFLOOR @ www.ultraflor.com to find the certified local contractor.
- C. Mock-Up: Before performing the work in this section, an adequate number of on-site mock-ups of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System representative of specified process, surface, finish, color and joint design/treatments must be installed for review and approval. These mock-ups should be installed using the same Installer personnel who will perform work. Approved mock-ups may become part of completed work, if undisturbed at time of substantial completion.
- D. Static Coefficient of Friction: A reading of not less than 0.5 for level floor surfaces shall be achieved and documented, as determined by certified an NFSI walkway auditor using the NFSI 101-A quality control test.
- E. Test Reports: Comply with the provisions of the following specifications and standards, except as otherwise noted or specified, or as accepted or directed by the Owner and/or Architect. All test data shall be recorded and submitted upon completion of job.
- 1. Section 03 30 00, Cast-In-Place Concrete
 - 2. ASTM E1155, Standard Test Method for Determining Floor Flatness and Levelness using the F number system
 - 3. ASTM E430, Standard Test Method for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry
 - 4. ASTM G23-81 Standard Test Method for Ultraviolet Light and Water Spray Resistance
 - 5. ACI 302.1R-04 Guide for Concrete Floor and Slab Construction
- F. Pre-Installation Conference: Prior to the installation of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System, an on-site conference shall be conducted to review specification requirements.
- 1. Required attendees include the Owner, Architect, General Contractor, ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System Subcontractor, ARDEX Representative and DIAMATIC Representative.
 - 2. The minimum agenda shall include:
 - a. Tour of work area, inspection and discussion of preparation of substrate and other pre-Installation conditions and issues.
 - b. Review of System requirements, including drawings, specifications and other contract documents.
 - c. Review of required submittals and completion status.
 - d. Review and finalization of installation schedule, and verification of availability of required materials, trained Installer personnel, equipment and facilities to execute specification and avoid delays.
 - e. Review of required inspection, testing, certification and material usage accounting procedures.
 - f. Review of methods and procedures for installation, including manufacturer's written instructions.
 - g. Review of governing regulations and requirements for insurance, certifications, inspection and testing, if applicable.
 - h. Review of temporary protection requirements during and after installation.
 - i. Review of cleaning procedures during and after installation.
 - j. Documentation proceedings, including corrective measures or actions required, and provision of a written copy of record to each participant.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original containers, bearing manufacturer's labels indicating brand name and directions for storage, factory numbered and sealed until ready for installation.
- B. Maintain records of product container numbers.
- C. Store all materials in a dry, climate-controlled environment at a minimum of 55°F (13°C) and maximum of 85°F (29°C).

1.5 SITE CONDITIONS

- A. Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation and other conditions affecting the floor finish.
- B. Close areas to traffic during and after ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System application for a time period recommended by the manufacturer.
- C. Inspect the existing substrate and document unsatisfactory conditions in writing. Verify that surfaces and site conditions are ready to receive work. Correct unacceptable conditions prior to installation of System. Commencement of work constitutes acceptance of substrate conditions.
- D. Existing concrete must be cured for a sufficient time period recommended by DIAMATIC and ARDEX before the application can begin.
- E. Where new or existing concrete is not within specified tolerances, install the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System Concrete Repair and Topping Materials at the required thickness to achieve tolerances. Comply with tolerance requirements in Section 03 30 00.
- F. Protect existing concrete and the new ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System from contamination by petroleum, oil, hydraulic fluid, acid and acidic detergents, paint and other liquid dripping from trades and equipment working over these substrates. If construction equipment must be used on these substrates, diaper all components that may drip fluids.
- G. Prohibit the placement and storage of construction materials over new ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System, to include ferrous metals and steel members.
- H. Prohibit vehicle parking and pipe cutting operations over existing concrete and the new ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System.
- I. Moisture Vapor and Alkalinity Testing
 - 1. Test existing concrete floors for alkalinity/pH, according to method indicated in ASTM F710. Acceptable results: pH between 9 and 10.
 - 2. Test existing concrete for moisture vapor transmission according to methods indicated in ASTM F1869. Acceptable results: not more than 5 pounds per 1,000 square feet in 24 hours.
 - 3. Test existing concrete for relative humidity using in situ probes according to ASTM F2170. Acceptable results: not more than 80%.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ARDEX Engineered Cements: www.ARDEX.com; 1-888-512-7339, 400 Ardex Park Drive Aliquippa, PA. 15001.
- B. DIAMATIC USA; www.DIAMATICusa.com; 1-866-295-5512, 5220 Gaines Street, San Diego, CA. 92110.
- C. No substitutions permitted.

1. Note: In some cases, and only with DIAMATIC's approval, burnishing, grinding and polishing machines may be substituted, provided that the specified DIAMATIC abrasives and blades can still be used.

2.2 SYSTEM INTEGRITY

- A. The ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System is an engineered and integrated complete installation system requiring strict adherence to all specified installation processes, equipment, diamond abrasives, concrete preparation, joint treatment and chemicals to achieve the intended result. Any substitutions from the specified products and/or processes will void the system warranty.

2.3 MATERIALS

A. DIAMATIC EQUIPMENT

1. DIAMATIC Micro Polisher - Burnishers: Specific weight and RPM are required to reach temperature of 100°F for application of FLOR-FINISH.
2. DIAMATIC BMG-780 or BMG-735: Planetary Grinder and Polisher, Large Platform: 32" planetary floor polisher. Head pressure of 600 lbs.
3. DIAMATIC BMG580PRO: Planetary Grinder and Polisher Medium Platform: 27" planetary floor polisher for smaller and intermediate areas.
4. DIAMATIC 5" Low Speed Grinder: Hand Held Polishing Tool: 5" hand floor polisher for edges with variable speed control range of 500 – 2200 RPM.
5. DIAMATIC 180EC: Walk Behind Edging grinder/polisher.
6. Vacuums: Dust Collection must be designed for filtering of concrete dust. Minimum air speed of 300 CFM for Large and Medium Platform equipment.
7. DIAMATIC BDC1324, BDC317P, BDC3140P, 6-54DC.
8. Crack Chaser: 7" Crack Vac with dolly or hand held 5" grinder with .375" thick/VCut diamond.
9. DIAMATIC Crack Vac or 5" high-speed grinder.
10. DIAMATIC Condor Applicator (densifier and polymer application, also for maintenance).
11. Blastrac/DIAMATIC ride on and walk behind floor scrapers with beveled steel scraper blades of various widths for removal of floor coverings.
12. DIAMATIC BMC335 Shaver: Self-propelled shaver/leveler for slab surface demolition and leveling.
13. Power generator capable of supplying a minimum output of 30kw and up, and 480 Volt three phase power.
14. DIAMATIC Diamond Abrasives and Blades
 - a. Metal Bonded Diamonds – 18/20, 30/40 Grit of soft, medium and hard bonded metal.
 - 1) **Note:** Concrete has hardness levels of soft, medium and hard. The hardness of the concrete will determine the required hardness of the metal bonded diamonds:
 - (a) Hard Concrete: Soft metal bonded diamonds
 - (b) Medium Concrete: Medium metal bonded diamonds
 - (c) Soft Concrete: Hard metal bonded diamonds
 - b. Transitional Diamonds, Ceramic Bonded - #0, #1, #2 Grit.
 - c. Resin Bonded Diamonds - 200, 400, 800, 1500 Grit.
 - d. FLOR-GRIT Diamond Impregnated Pads – 400, 800, 1500, 3000 Grit.
 - e. Metal Bonded Diamond blades 1/8" to 3/4" (3 mm to 18 mm) thick.

B. ULTRAFLOAR ARDEX DIAMATIC CONCRETE TREATMENT CHEMICALS

1. ARDEX DIAMATIC FLOR-SIL™ Lithium Densifier for standard concrete and terrazzo surfaces
2. ARDEX DIAMATIC FLOR-FINISH Stain and Wear Protection Treatment (high-gloss)
3. DIAMATIC FLOR Maintainer™ Gloss, Stain and Wear Protection Routine Maintenance Treatment

C. ARDEX CRACK AND JOINT TREATMENT MATERIALS

1. For complete installation instructions and required tools, please refer to the individual ARDEX Technical Brochures available for each product.
2. ARDEX ARDIBOND AP™ Fast-Setting, All-Purpose Repair Epoxy
3. ARDEX ARDISEAL™ RAPID PLUS Semi-Rigid Joint Sealant

4. ARDEX ARDIFIX™ Low Viscosity Rigid Polyurethane Crack and Joint Repair
- D. ARDEX DIAMATIC ULTRAFLOOR CONCRETE REPAIR AND TOPPING MATERIALS
1. For complete installation instructions and required tools, please refer to the individual ARDEX Technical Brochures available for each product.
 2. For polishing instructions, please refer to the individual ULTRAFLOOR ARDEX DIAMATIC specifications for each component.
 3. Where a self-leveling topping material is needed for interior application prior to polishing, ARDEX DIAMA-TOP Polished Concrete Topping shall be installed (Gray or White).
 4. Any pinholes that need to be filled shall be filled with ARDEX DIAMA-FILL™ Filling Compound for Polished Concrete, Concrete Terrazzo and Other Cementitious Wear Surfaces (Medium Gray, Beige, White or Black) applied at the appropriate time during the polishing process.
 5. Where a thin coat interior or exterior smoothing application is required prior to polishing, ARDEX DIAMA-COAT™ Concrete Coating (gray) or ARDEX DIAMA-COAT FINE™ Concrete Coating shall be installed (white or gray)
 6. Where a micro-finish is required for interior application prior to polishing, ARDEX DIAMA-SKIN™ Polished Concrete Finish shall be installed (white or gray)
 7. Where interior or exterior patching is required prior to polishing, ARDEX DIAMA-PATCH™ Concrete Patch shall be installed.
 8. Where less than 1/8" width crack repair is required prior to polishing, ARDEX ARDI-FIX shall be installed.
 9. Where greater than 1/8" width crack repair is required prior to polishing, ARDEX ARDI-BOND AP shall be installed.
 10. Where concrete control joints are required to be repaired prior to polishing, ARDEX ARDI-SEAL RAPID PLUS shall be installed.
- E. DIAMATIC PROTECTION MATERIALS
1. To prevent minor damage from light trade traffic during build out of site, DIAMATIC PRIMO-COVER Protective Floor Covering or DIAMATIC ECONO-COVER Protective Floor Covering for the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System shall be installed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Inspect all concrete substrates and conditions under which the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System to be installed.
- B. Verify that all surfaces and site conditions are ready to receive work; document and correct conditions detrimental to timely and proper installation of work. Beginning work constitutes acceptance of substrate condition.
- C. Verify that existing concrete has cured a minimum of 28 days and meets finish and surface profile requirements in Division 03 Section "Cast-In-Place Concrete," before installing the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System.
- D. Conduct pre-installation conference, per Section 1.3 F.

3.2 PREPARATION

- A. Demolition
 1. Clear surfaces of any debris and construction materials.
 2. If a generator is not provided by the Installer, power connections for the equipment of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System shall be located and prepared by general contractor.
 3. Using the appropriate mechanical means and methods, remove existing floor coverings and coatings, including but not limited to carpet VCT, ceramic tile and grout, wood, epoxy/ urethane, quartz, mastic, adhesives, paint or other non-concrete floor materials.

- a. **Note:** The mechanical removal of resilient flooring, backing, lining felt, cutback and other adhesives can be hazardous, as certain materials may contain asbestos or crystalline silica. Do not sand, dry sweep, dry scrape, drill, saw, bead blast, grind, mechanically chip or pulverize these materials, as harmful dust may result. Inhalation of this dust may cause asbestosis or other bodily harm. Please consult the adhesive manufacturer, the Resilient Floor Covering Institute (www.rfci.com) and all applicable government agencies for rules and regulations concerning the handling and removal asbestos-containing materials.
 4. Prevent any damage to concrete slab surface during demolition from chipping hammers. Existing flooring should be removed mechanically with walk-behind or ride-on scraping equipment.
 5. Prepare the existing concrete mechanically via scarification, shot blasting or other means, including diamond grinding by using aggressive, metal bonded DIAMATIC Polycrystalline diamonds (18/20 Grit or 30/40 Grit), to remove all contaminants and provide a sound concrete surface free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil and other contaminants.
 6. Chemical preparation of the substrate is NOT acceptable, including but not limited to acid etching, sweeping compounds, solvents and adhesive removers.
 7. Suppress dust during demolition with the use of dust collection equipment using HEPA/concrete filtration devices to reduce or eliminate airborne concrete and substrate dust.
 8. Where existing concrete is cracked, damaged, spalled, not within specified tolerance, or contains unacceptable levels of alkalinity or moisture vapor, the Installer of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System will evaluate conditions and proceed with appropriate ULTRAFLOOR System components.
- B. Concrete Repair
1. Cracks (Indoor/Outdoor)
 - a. Crack repair shall be completed after the first metal bond diamond grind and floor cleaning.
 - b. Cracks to be repaired in the concrete surface shall be crack chased out on a high-speed angle grinder to a minimum depth of 3/8" and made to eliminate any feathered edges.
 - c. The edges of the crack may be taped or coated with ARDEX DIAMATIC FLOR-SIL to eliminate possible staining from repair material.
 - d. Clean out any dust or debris and then apply ARDEX ARDIBOND AP or ARDEX ARDIFIX to fill the crack chased areas. Read and follow ARDEX ARDIBOND AP or ARDEX ARDIFIX detailed instructions as outlined in the Technical Data Sheet.
 - e. All crack filling material shall be overfilled. Immediately after application of ARDEX ARDIBOND AP or ARDEX ARDIFIX, silica sand or the concrete grindings may be broadcast to rejection over the crack repair material. The silica or floor grindings will reduce the visibility of the repaired crack and take on a similar color and appearance to surrounding concrete when stained.
 2. Cracks smaller than 1/8" can be left as a part of the finished concrete, unless otherwise specified. Cracks shall be vacuumed to remove all loose debris and dirt.
 3. Cracks smaller than 1/8" can be filled with ARDEX ARDIFIX.
 4. Cracks greater than 1/8" shall be filled with ARDEX ARDIBOND AP.
 5. Cracks shall be overfilled and broadcast to refusal with play sand or concrete shavings, and shall be subsequently ground down to the level of the concrete surface.
 6. All crack filling material shall installed and allowed to cure in strict accordance with the manufacturer's recommendations before proceeding with the next step in the ULTRAFLOOR process.
- C. Spalls (Indoor/Outdoor)
1. Spall repair to be completed after the first metal bond diamond grind and floor cleaning, or prior to the beginning of the ULTRAFLOOR process installation.
 2. For complete installation details for spall repair materials, please refer to the ARDEX Technical Brochure.
 3. For polishing instructions, please refer to the individual ULTRAFLOOR ARDEX DIAMATIC specifications for each component.
 4. Spalls up to 4" (10 cm) wide and 1" (2.5 cm) deep shall be filled with ARDEX DIAMA-PATCH. Allow a minimum of 16 to 24 hours drying time prior to beginning the ULTRAFLOOR polishing process.

5. **OR** Spalls up to 4" (10 cm) wide and 1" (2.5 cm) deep can be filled with ARDEX ARDIBOND AP or ARDEX ARDIFIX. Overfill all applications and broadcast sand or concrete grindings to refusal so that they may be ground down to match the level of the concrete surface after dry time.
 6. Spalls greater than 4" (10 cm) wide and 1" (2.5 cm) deep shall be filled with ARDEX DIAMA-PATCH. Allow a minimum of 16 to 24 hours drying time prior to beginning the ULTRAFLOOR polishing process.
- D. Large Area Concrete Repair (Indoor)
1. Where large area concrete repair is needed, ARDEX DIAMA-TOP shall be used in accordance with the information presented in the ARDEX Technical Brochure. For polishing instructions, please refer to the ARDEX DIAMA-TOP component specification.
- E. Joint Fill (Indoor/Outdoor)
1. All joint fill materials shall be installed in accordance with the written recommendations provided in the ARDEX Technical Brochures.
 2. If the joint filling will occur after the polishing process, apply ARDEX DIAMATIC FLOR-SIL or ARDEX DIAMATIC FLOR-HARD, tape, or soap to the edge of the concrete to keep the joint filler from staining the concrete.
 3. Prior to filling joints, repair badly spalled joint edges per ACI 302.1R-04.
 - a. Grind the outside edges of all spalls to eliminate any feathered edges and make sure that the minimum depth of the spall is ½". Mechanically prepare the joint area, and chip out any concrete less than ½" in depth.
 - b. ii. Apply ARDEX ARDIBOND AP or ARDEX ARDIFIX to the spalled area using a putty knife to reform the edges and surface to the original shape.
 4. Once the spalled areas are repaired, the entire joint and spall areas shall be filled with ARDEX ARDIBOND AP. Once cured, saw cut the joint to the original dimensions, and then clean the joint and fill with ARDEX ARDISEAL RAPID PLUS.
 5. Slightly overfill the joint with enough material to shave flush with the concrete. If the level of the joint filler sinks down, immediately add enough product to over fill the joint. Shave the joint filler flush with the concrete with a shaving tool with a sharp blade. ARDISEAL RAPID PLUS can be shaved in 30 to 40 minutes at 70°F (21°C).
 6. Remove all tape and/or soap from the surface around the joint.
 7. MicroPolish the surface with appropriate grit DIAMATIC FLOR-GRIT pad.

3.3 GLOSS ATTAINMENT (ASTM E430)

- A. Readings shall be taken not less than 10' (3 m) on center in field areas and within 1' (0.3 m) of floor area perimeters. In no case shall a reading be below 2% of specified minimum sheen:
1. Level A Sheen – Low Reflectivity readings of less than 35.
 2. Level B Sheen – Medium Reflectivity readings of 36 to 50.
 3. Level C Sheen – Medium High Reflectivity readings of 51 to 65.
 4. Level D Sheen – High Reflectivity readings of 66 or higher.
- B. For instructions on achieving gloss levels, refer to the appropriate sub-section of section 3.04 below.

3.4 POLISHING

A. CONCRETE REMEDIATION

1. Use the grinding and polishing steps outlines below to achieve the desired gloss level. Please note that when grinding and polishing a cross hatch pattern should be used. This process is to commence after the completion of the floor demolition, if necessary.
2. Level A Sheen
 - a. GRIND/POLISH #1: 30/40 Grit Metal Bonded Diamonds.
 - b. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #0 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum, and wash the floor as necessary to remove all residual dust.

- f. GRIND/POLISH #3: 100 Grit Resin Bonded Diamonds.
 - g. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - h. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) ii. For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) iii. Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) iv. Allow to dry for 16-24 hours before continuing to the next polishing step.
 - i. Apply ARDEX DIAMATIC FLOR-SIL per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - j. 10. Allow ARDEX DIAMATIC FLOR-SIL to dry before continuing on to the next step.
 - k. 11. GRIND/POLISH #4: 200 Resin Bonded Diamonds.
 - l. 12. Broom and vacuum the floor to remove all residual dust.
 - m. 13. MICROPOLISH/BURNISH #1: FLOR-GRIT 400 Diamond Impregnated Pad
 - n. 14. Dry mop the floor clean to remove all debris.
 - o. 15. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
 - p. 16. Allow to dry a minimum of 15 minutes.
 - q. 17. MICROPOLISH/BURNISH #2: FLOR-GRIT 400 Diamond Impregnated Pad.
 - r. 18. Dry mop the floor clean to remove all debris.
 - s. 19. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
 - t. 20. Allow to dry a minimum of 15 minutes.
 - u. 21. MICROPOLISH/BURNISH #3: FLOR-GRIT 400 Diamond Impregnated Pad.
3. Level B Sheen
- a. GRIND/POLISH #1: 30/40 Grit Metal Bonded Diamonds.
 - b. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #0 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - f. GRIND/POLISH #3: 200 Grit Resin Bonded Diamonds.
 - g. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - h. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) Allow to dry for 16-24 hours before continuing to the next polishing step.
 - i. Apply ARDEX DIAMATIC FLOR-SIL per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - j. Allow ARDEX DIAMATIC FLOR-SIL to dry before continuing on to the next step.
 - k. GRIND/POLISH #4: 400 Resin Bonded Diamonds.
 - l. Broom and vacuum the floor to remove all residual dust.
 - m. MICROPOLISH/BURNISH #1: FLOR-GRIT 400 Diamond Impregnated Pad
 - n. Dry mop the floor clean to remove all debris.
 - o. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
 - p. Allow to dry a minimum of 15 minutes.
 - q. MICROPOLISH/BURNISH #2: FLOR-GRIT 800 Diamond Impregnated Pad.
 - r. Dry mop the floor clean to remove all debris.
 - s. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
 - t. Allow to dry a minimum of 15 minutes.
 - u. MICROPOLISH/BURNISH #3: FLOR-GRIT 1500 Diamond Impregnated Pad.

4. Level C Sheen
 - a. GRIND/POLISH #1: 30/40 Grit Metal Bonded Diamonds.
 - b. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #0 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - f. GRIND/POLISH #3: 200 Grit Resin Bonded Diamonds.
 - g. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - h. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) Allow to dry for 16-24 hours before continuing to the next polishing step.
 - i. Apply ARDEX DIAMATIC FLOR-SIL per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - 1) Allow ARDEX DIAMATIC FLOR-SIL to dry before continuing on to the next step.
 - 2) GRIND/POLISH #4: 400 Resin Bonded Diamonds.
 - 3) Broom and vacuum the floor to remove all residual dust.
 - 4) GRIND/POLISH #5: 800 Resin Bonded Diamonds.
 - 5) Broom and vacuum the floor to remove all residual dust.
 - 6) MICROPOLISH/BURNISH #1: FLOR-GRIT 800 Diamond Impregnated Pad
 - 7) Dry mop the floor clean to remove all debris.
 - 8) Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
 - 9) Allow to dry a minimum of 15 minutes.
 - 10) MICROPOLISH/BURNISH #2: FLOR-GRIT 1500 Diamond Impregnated Pad.
 - 11) Dry mop the floor clean to remove all debris.
 - 12) Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
 - 13) Allow to dry a minimum of 15 minutes.
 - 14) MICROPOLISH/BURNISH #3: FLOR-GRIT 3000 Diamond Impregnated Pad.
5. Level D Sheen
 - a. GRIND/POLISH #1: 30/40 Grit Metal Bonded Diamonds.
 - b. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #0 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - f. GRIND/POLISH #3: 200 Grit Resin Bonded Diamonds.
 - g. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - h. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) xiii. Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) xiv. For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) xv. Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) xvi. Allow to dry for 16-24 hours before continuing to the next polishing step.
 - i. Apply ARDEX DIAMATIC FLOR-SIL per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - j. Allow ARDEX DIAMATIC FLOR-SIL to dry before continuing on to the next step.
 - k. GRIND/POLISH #4: 400 Resin Bonded Diamonds.
 - l. Broom and vacuum the floor to remove all residual dust.
 - m. GRIND/POLISH #5: 800 Resin Bonded Diamonds.
 - n. Broom and vacuum the floor to remove all residual dust.
 - o. GRIND/POLISH #6: 1500 Resin Bonded Diamonds.

- p. Broom and vacuum the floor to remove all residual dust.
- q. MICROPOLISH/BURNISH #1: FLOR-GRIT 1500 Diamond Impregnated Pad
- r. Dry mop the floor clean to remove all debris.
- s. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
- t. Allow to dry a minimum of 15 minutes.
- u. MICROPOLISH/BURNISH #2: FLOR-GRIT 3000 Diamond Impregnated Pad.
- v. Dry mop the floor clean to remove all debris.
- w. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
- x. Allow to dry a minimum of 15 minutes.
- y. MICROPOLISH/BURNISH #3: FLOR-GRIT 3000 Diamond Impregnated Pad.

B. NEW CONCRETE POLISHING

1. Use the grinding and polishing steps outlines below to achieve the desired gloss level. Please note that when grinding and polishing a cross hatch pattern should be used.
2. Level A Sheen
 - a. GRIND/POLISH #1: 120/140 Grit Metal Bonded Diamonds.
 - b. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #1 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - f. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) i. Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) ii. For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) iii. Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) iv. Allow to dry for 16-24 hours before continuing to the next polishing step.
 - g. Apply ARDEX DIAMATIC FLOR-SIL per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - h. Allow ARDEX DIAMATIC FLOR-SIL to dry before continuing on to the next step.
 - i. GRIND/POLISH #3: 200 Resin Bonded Diamonds.
 - j. Broom and vacuum the floor to remove all residual dust.
 - k. MICROPOLISH/BURNISH #1: FLOR-GRIT 400 Diamond Impregnated Pad
 - l. Dry mop the floor clean to remove all debris.
 - m. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
 - n. Allow to dry a minimum of 15 minutes.
 - o. MICROPOLISH/BURNISH #2: FLOR-GRIT 400 Diamond Impregnated Pad.
 - p. Dry mop the floor clean to remove all debris.
 - q. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
 - r. Allow to dry a minimum of 15 minutes.
 - s. MICROPOLISH/BURNISH #3: FLOR-GRIT 400 Diamond Impregnated Pad.
3. Level B Sheen
 - a. GRIND/POLISH #1: 120/140 Grit Metal Bonded Diamonds.
 - b. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #1 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - f. GRIND/POLISH #3: 200 Grit Resin Bonded Diamonds.
 - g. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - h. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) i. Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) vi. For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.

- 3) vii. Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) viii. Allow to dry for 16-24 hours before continuing to the next polishing step.
 - i. Apply ARDEX DIAMATIC FLOR-SIL per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - j. Allow ARDEX DIAMATIC FLOR-SIL to dry before continuing on to the next step.
 - k. GRIND/POLISH #4: 400 Resin Bonded Diamonds.
 - l. Broom and vacuum the floor to remove all residual dust.
 - m. MICROPOLISH/BURNISH #1: FLOR-GRIT 400 Diamond Impregnated Pad
 - n. Dry mop the floor clean to remove all debris.
 - o. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
 - p. Allow to dry a minimum of 15 minutes.
 - q. MICROPOLISH/BURNISH #2: FLOR-GRIT 800 Diamond Impregnated Pad.
 - r. Dry mop the floor clean to remove all debris.
 - s. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
 - t. Allow to dry a minimum of 15 minutes.
 - u. MICROPOLISH/BURNISH #3: FLOR-GRIT 1500 Diamond Impregnated Pad.
4. Level C Sheen
- a. GRIND/POLISH #1: 120/140 Grit Metal Bonded Diamonds.
 - b. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #1 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - f. GRIND/POLISH #3: 200 Grit Resin Bonded Diamonds.
 - g. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - h. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) Allow to dry for 16-24 hours before continuing to the next polishing step.
 - i. Apply ARDEX DIAMATIC FLOR-SIL per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - j. Allow ARDEX DIAMATIC FLOR-SIL to dry before continuing on to the next step.
 - k. GRIND/POLISH #4: 400 Resin Bonded Diamonds.
 - l. Broom and vacuum the floor to remove all residual dust.
 - m. GRIND/POLISH #5: 800 Resin Bonded Diamonds.
 - n. Broom and vacuum the floor to remove all residual dust.
 - o. MICROPOLISH/BURNISH #1: FLOR-GRIT 800 Diamond Impregnated Pad
 - p. Dry mop the floor clean to remove all debris.
 - q. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
 - r. Allow to dry a minimum of 15 minutes.
 - s. MICROPOLISH/BURNISH #2: FLOR-GRIT 1500 Diamond Impregnated Pad.
 - t. Dry mop the floor clean to remove all debris.
 - u. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
 - v. Allow to dry a minimum of 15 minutes.
 - w. MICROPOLISH/BURNISH #3: FLOR-GRIT 3000 Diamond Impregnated Pad.
5. Level D Sheen
- a. GRIND/POLISH #1: 120/140 Grit Metal Bonded Diamonds.
 - b. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #1 Transitional Diamonds, Ceramic Bonded.

- e. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
- f. GRIND/POLISH #3: 200 Grit Resin Bonded Diamonds.
- g. Broom, vacuum, and wash the floor as necessary to remove all residual dust.
- h. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) xiii. Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) xiv. For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) xv. Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) xvi. Allow to dry for 16-24 hours before continuing to the next polishing step.
- i. Apply ARDEX DIAMATIC FLOR-SIL per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
- j. Allow ARDEX DIAMATIC FLOR-SIL to dry before continuing on to the next step.
- k. GRIND/POLISH #4: 400 Resin Bonded Diamonds.
- l. Broom and vacuum the floor to remove all residual dust.
- m. GRIND/POLISH #5: 800 Resin Bonded Diamonds.
- n. Broom and vacuum the floor to remove all residual dust.
- o. GRIND/POLISH #6: 1500 Resin Bonded Diamonds.
- p. Broom and vacuum the floor to remove all residual dust.
- q. MICROPOLISH/BURNISH #1: FLOR-GRIT 1500 Diamond Impregnated Pad
- r. Dry mop the floor clean to remove all debris.
- s. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
- t. Allow to dry a minimum of 15 minutes.
- u. MICROPOLISH/BURNISH #2: FLOR-GRIT 3000 Diamond Impregnated Pad.
- v. Dry mop the floor clean to remove all debris.
- w. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
- x. Allow to dry a minimum of 15 minutes.
- y. MICROPOLISH/BURNISH #3: FLOR-GRIT 3000 Diamond Impregnated Pad.

3.5 EDGES

- A. Where desired, polished edge work of ARDEX DIAMA-TOP shall be done with a 5" or 7" DIAMATIC Hand Held or Walk Behind polishing tool. The edge polishing process will match the corresponding steps outlined above for the desired gloss level, and each edge polishing step shall be done immediately before the matching main polishing step.
- B. For polishing standard concrete edges, please refer to the main specification.
- C. NOTE: All grinding and polishing completed with grinder/polisher equipment connected to a dust collector.

3.6 ACCEPTANCE

- A. Remove all installation materials and any foreign materials resulting from the installation, from the site.
- B. Clean adjacent surfaces and materials.
- C. Perform post job walk to ensure that the ULTRAFLOOR ARDEX Concrete System has been completed per the process spec.
- D. Take pictures of final product for documentation and submittal, if requested or required.

3.7 PROTECTION

- A. Prevent any spills or stains from coming into contact with the floor. Clean any spills that may occur as quickly as possible.
- B. Avoid moisture for 72 hours after installation. Don't permit standing water for this period or place any protective plastic sheeting, rubber matting, rugs or furniture that can prevent proper drying, thereby trapping moisture, which can result in a cloudy effect on the floor.
- C. Light pedestrian use only in the 24 hours after installation. Normal traffic recommended 14 days after completion of ULTRAFLOAR ARDEX DIAMATIC Concrete Topping System.
- D. Protect the finished ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System from continuing construction and build out as needed by installing the DIAMATIC PRIMO-COVER Protective Floor Covering or DIAMATIC ECONO-COVER Protective Floor Covering.
 - 1. The installation of the DIAMATIC Protective Covering must be approved by the Installer and General Contractor of the ULTRAFLOAR installation.
 - 2. If the DIAMATIC Protective Cover is damaged during use, then that section must be cut out and replaced to maintain the integrity of the protective covering.
 - 3. The DIAMATIC Protective Cover can be removed after build out is complete.

3.8 ONGOING MAINTENANCE

- A. **IMPORTANT NOTICE:** Maintaining the ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System and adherence to a recommended cleaning schedule will help the floor hold its mechanically polished gloss longer and greatly reduces the absorption of spilled liquids. The treated concrete floor is easily maintained by regular cleaning with the Maintenance/Post Cleaning procedure, accompanied by Micro-Polishing.
- B. Newly Installed ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System
 - 1. Restrict water cleaning for 72 hours after installation of ULTRAFLOAR. Use only a dry mop to clean. Avoid putting mats or covering treated surface to allow coating to fully cure out.
 - 2. **DO NOT USE** cleaners that are acidic or that have citrus (de-limonene) or Butyl compounds. Although the ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System is chemical and stain resistant, the application of these high acid cleaners may etch the surface and cause a residual stain. Regular maintenance and cleaning will help prolong surface shine.
- C. Daily Maintenance and Cleaning
 - 1. Once the system is fully cured out (min. 72 hours), routinely sweep, dry mop and wash with neutral pH cleaners or water using a mechanical auto scrubber with vacuum to pick up any residual standing water.
 - 2. **DO NOT USE** cleaners that are acidic or that have citrus (de-limonene) or Butyl compounds. Although the ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System is chemical and stain resistant, the application of these high acid cleaners may etch the surface and cause a residual stain. Regular maintenance and cleaning will help prolong surface shine.
- D. Routine Maintenance and Cleaning (dependent upon floor wear and traffic)
 - 1. Follow the daily maintenance process.
 - 2. Burnish/MicroPolish ULTRAFLOAR surface with 3000 grit diamond impregnated pad on a high speed buffer.
 - 3. Apply DIAMATIC FLOR-MAINTAINER diluted with parts water using a DIAMATIC CONDOR APPLICATOR or microfiber pad at a coverage rate of 8000 to 10000 square feet per gallon.
 - 4. Burnish/MicroPolish with DIAMATIC FLOR-GRIT 3000 diamond impregnated pad.
 - 5. Dry mop to remove any debris.
 - 6. **DO NOT USE** cleaners that are acidic or that have citrus (de-limonene) or Butyl compounds. Although the ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System is chemical and stain resistant, the application of these high acid cleaners may etch the surface and cause a residual stain. Regular maintenance and cleaning will help prolong surface shine.

- E. ULTRAFLOOR Rejuvenation (recommended application every 1 to 2 years depending upon floor wear and traffic)
1. Follow the daily.
 2. Burnish/MicroPolish ULTRAFLOOR surface with 3000 grit diamond impregnated pad on a high speed buffer.
 3. Application of ARDEX DIAMATIC FLOR-FINISH applied with Condor applicator or microfiber pads. Follow manufacture application instructions.
 4. Burnish/MicroPolish with DIAMATIC FLOR-GRIT 3000 diamond impregnated pad.
 5. Dry mop to remove any debris.
 6. DO NOT USE cleaners that are acidic or that have citrus (de-limonene) or Butyl compounds. Although the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System is chemical and stain resistant, the application of these high acid cleaners may etch the surface and cause a residual stain. Regular maintenance and cleaning will help prolong surface shine.

END OF SECTION

SECTION 033545 POLISHED CONCRETE TOPPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Products and procedures for the installation of the ARDEX DIAMA-TOP™ Polished Concrete Topping component of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System using a multi-step dry mechanical process and accessories indicated, specified or required to complete system and achieve specified finish:
 - a. ARDEX DIAMA-TOP™ Polished Concrete Topping (Gray or White)
 - b. ARDEX EP 2000™ Substrate Preparation Epoxy
 - c. DIAMATIC Mechanical Diamond Grinding and Polishing Equipment
 - d. ULTRAFLOOR ARDEX DIAMATIC Concrete Treatment Chemicals
2. Products and procedures for the initial and long term maintenance of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System.
3. All equipment, diamond products, concrete repair and topping materials, crack and joint treatments, and chemicals are specified by DIAMATIC Management Services, DIAMATIC and ARDEX.

1.2 SUBMITTALS

- A. Product Data: Submit Manufacturer's technical literature for each product indicated, specified or required. Include manufacturer's technical data, application instructions, recommendations and MSDS.
- B. Installer Qualifications: Data for company, principal personnel, experience and training. Provide a letter documenting installer's accreditation and certification compliance, as specified under quality assurance.
- C. Test Reports: Provide field quality control sheen gloss reading and static coefficient of friction test results conducted as specified and recorded on floor plan diagram confirming compliance with specified performance criteria.
- D. Warranty: Provide manufacturer's warranty of ULTRAFLOOR System materials, contractor workmanship and finish standards.
- E. Maintenance Data: Provide manufacturer's instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under intended use. These instructions should contain precautions against cleaning products and methods that may be detrimental to finishes and performance.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: The ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System consists of a process and products engineered and manufactured by ARDEX and DIAMATIC. Any substitutions are not permitted and void warranty.
- B. Installer Qualifications:
 1. Installer must be experienced and factory-trained in the installation of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System, including the use of DIAMATIC equipment and diamond abrasives, and ARDEX DIAMATIC concrete preparation, joint treatment, and chemical hardening and finishing materials.
 2. Installer must be experienced in performing specified work similar in design, products and scope of this project, with a documented track record of successful, in-service performance and with sufficient production capabilities, facilities and personnel to produce specified work.

3. A factory-trained, competent supervisor must be maintained on site during all times during which specified work is performed.
 4. Installer must provide written documentation from the manufacturer confirming the Installer's accreditation and training at the ELITE/CHOICE level from both ARDEX and DIAMATIC on installation of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System and related equipment and processes.
- C. Mock-Up: Before performing the work in this section, an adequate number of on-site mock-ups of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System representative of specified process, surface, finish, color and joint design/treatments must be installed for review and approval. These mock-ups should be installed using the same Installer personnel who will perform work. Approved mock-ups may become part of completed work, if undisturbed at time of substantial completion.
- D. Static Coefficient of Friction: A reading of not less than 0.5 for level floor surfaces shall be achieved and documented, as determined by a certified NFSI walkway auditor using the NFSI 101-A quality control test.
- E. Test Reports: Comply with the provisions of the following specifications and standards, except as otherwise noted or specified, or as accepted or directed by the Owner and/or Architect. All test data shall be recorded and submitted upon completion of job.
1. Section 03 30 00, Cast-In-Place Concrete
 2. ASTM E1155, Standard Test Method for Determining Floor Flatness and Levelness using the F number system
 3. ASTM E430, Standard Test Method for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry
 4. ASTM G23-81 Standard Test Method for Ultraviolet Light and Water Spray Resistance
 5. ACI 302.1R-04 Guide for Concrete Floor and Slab Construction
- F. Pre-Installation Conference: Prior to the installation of the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System, an on-site conference shall be conducted to review specification requirements.
1. Required attendees include the Owner, Architect, General Contractor, ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System Subcontractor, ARDEX Representative and DIAMATIC Representative.
 2. The minimum agenda shall include:
 3. Tour of work area, inspection and discussion of preparation of substrate and other pre-Installation conditions and issues.
 4. Review of System requirements, including drawings, specifications and other contract documents.
 5. Review of required submittals and completion status.
 6. Review and finalization of installation schedule, and verification of availability of required materials, trained Installer personnel, equipment and facilities to execute specification and avoid delays.
 7. Review of required inspection, testing, certification and material usage accounting procedures.
 8. Review of methods and procedures for installation, including manufacturer's written instructions.
 9. Review of governing regulations and requirements for insurance, certifications, inspection and testing, if applicable.
 10. Review of temporary protection requirements during and after installation.
 11. Review of cleaning procedures during and after installation.
 12. Documentation proceedings, including corrective measures or actions required, and provision of a written copy of record to each participant.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original containers, bearing manufacturer's labels indicating brand name and directions for storage, factory numbered and sealed until ready for installation.
- B. Maintain records of product container numbers.

- C. Store all materials in a dry, climate-controlled environment at a minimum of 55°F (13°C) and maximum of 85°F (29°C).

1.5 SITE CONDITIONS

- A. ARDEX DIAMA-TOP is a cementitious material. Observe the basic rules of concrete work. The ideal temperature at which ARDEX self-leveling leveling products should be installed is 70°F (21°C). Do not install below 50°F (10°C) or above 85°F (29°C) surface temperature. Install quickly if floor is warm (above 70°F/21°C and up to 85°F/29°C) and follow warm weather precautions available from the ARDEX Technical Service Department (888) 512-7339. Never mix with cement or additives other than ARDEX-approved products.
- B. ARDEX DIAMA-TOP is a Portland cement-based product and, as with any cementitious material, variations in color can occur as a function of job-site conditions.
- C. Close areas to traffic during and after the ARDEX DIAMA-TOP application for a time period recommended by the manufacturer.
- D. Inspect the existing substrate and document unsatisfactory conditions in writing. Verify that surfaces and site conditions are ready to receive work. Correct unacceptable conditions prior to installation of System. Commencement of work constitutes acceptance of substrate conditions.
- E. Existing concrete must be cured for a sufficient time period recommended by DIAMATIC and ARDEX before the application can begin.
- F. Existing concrete must be structural grade, with a minimum compressive strength of 3000 psi and a minimum density of 100 pcf.
- G. Protect the new ARDEX DIAMA-TOP from contamination by petroleum, oil, hydraulic fluid, acid and acidic detergents, paint and other liquid dripping from trades and equipment working over these substrates. If construction equipment must be used on these substrates, diaper all components that may drip fluids.
- H. Prohibit the placement and storage of construction materials over new ARDEX DIAMA-TOP, to include ferrous metals and steel members.
- I. Prohibit vehicle parking and pipe cutting operations over existing concrete and the new ARDEX DIAMA-TOP Polished Concrete System.
- J. Moisture Vapor and Alkalinity Testing
 1. Test existing concrete floors for alkalinity/pH according to method indicated in ASTM F710. Acceptable results: pH between 9 and 10.
 2. Test existing concrete for moisture vapor transmission according to methods indicated in ASTM F1869. Acceptable results: not more than 5 pounds per 1,000 square feet in 24 hours.
 3. Test existing concrete for relative humidity using in situ probes according to ASTM F2170. Acceptable results: not more than 80%.
 4. Correct unacceptable moisture/humidity conditions utilizing the ARDEX MC™ ULTRA MOISTURE CONTROL SYSTEM prior to the installation of ARDEX DIAMA-TOP.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ARDEX Engineered Cements: www.ardex.com; 1-888-512-7339, 400 Ardex Park Drive Aliquippa, PA 15001.
- B. DIAMATIC USA; www.diamaticusa.com; 1-866-295-5512, 5220 Gaines Street, San Diego, CA 92110.
- C. No substitutions permitted.

1. Note: In some cases, and only with DIAMATIC's approval, burnishing, grinding and polishing machines may be substituted, provided that the specified DIAMATIC abrasives and blades can still be used.

2.2 SYSTEM INTEGRITY

- A. The ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System is an engineered and integrated complete installation system requiring strict adherence to all specified installation processes, equipment, diamond abrasives, concrete preparation, joint treatment and chemicals to achieve the intended result. Any substitutions from the specified products and/or processes will void the system warranty.

2.3 MATERIALS

A. ARDEX CONCRETE REPAIR AND TOPPING MATERIALS

1. The self-leveling concrete repair material shall be ARDEX DIAMA-TOP Polished Concrete Topping.
2. The primer for areas to receive ARDEX DIAMA-TOP will be ARDEX EP 2000 Substrate Preparation Epoxy.
3. For use in pre-leveling or when the material is installed over 2" thick, aggregate shall be well graded, washed gravel (1/8" to 1/4" or larger).
4. Water shall be clean, potable and sufficiently cool (not warmer than 70°F/21°C).
5. Any pinholes that need to be filled shall be filled with ARDEX DIAMA-FILL™ Filling Compound for Polished Concrete, Concrete Terrazzo and Other Cementitious Wear Surfaces (Medium Gray or White) applied at the appropriate time during the polishing process.
6. For complete installation instructions and required tools, please refer to the individual ARDEX Technical Brochures available for each product.

B. DIAMATIC EQUIPMENT

1. DIAMATIC Micro Polisher - Burnishers: Specific weight and RPM are required to reach temperature of 100°F for application of FLOR-FINISH.
2. DIAMATIC BMG-780 or BMG-735: Planetary Grinder and Polisher, Large Platform: 32" planetary floor polisher. Head pressure of 600 lbs.
3. DIAMATIC BMG580PRO: Planetary Grinder and Polisher Medium Platform: 27" planetary floor polisher for smaller and intermediate areas.
4. DIAMATIC 5" Low Speed Grinder: Hand Held Polishing Tool: 5" hand floor polisher for edges with variable speed control range of 500 – 2200 RPM.
5. DIAMATIC 180EC: Walk Behind Edging grinder/polisher.
6. Vacuums: Dust Collection must be designed for filtering of concrete dust. Minimum air speed of 300 CFM for Large and Medium Platform equipment.
7. DIAMATIC BDC1324, BDC317P, BDC3140P, 6-54DC.
8. Crack Chaser: 7" Crack Vac with dolly or hand held 5" grinder with .375" thick/VCut diamond.
9. DIAMATIC Crack Vac or 5" high-speed grinder.
10. DIAMATIC Condor Applicator (densifier and polymer application, also for maintenance).
11. Blastrac/DIAMATIC ride on and walk behind floor scrapers with beveled steel scraper blades of various widths for removal of floor coverings.
12. DIAMATIC BMC335 Shaver: Self-propelled shaver/leveler for slab surface demolition and leveling.
13. Power generator capable of supplying a minimum output of 30kw and up, and 480 Volt three phase power.
14. DIAMATIC Diamond Abrasives and Blades
 - a. Metal Bonded Diamonds - 60/80 Grit of medium and hard bonded metal.
 - b. Transitional Diamonds Ceramic Bonded - #1 Grit.
 - c. Resin Bonded Diamonds - 200, 400, 800, 1500 Grit.
 - d. FLOR-GRIT Diamond Impregnated Pads - 800, 1500, 3000 Grit.
 - e. Metal Bonded Diamond blades 1/8" to 3/4" (3 mm to 18 mm) thick.

C. ULTRAFLOAR ARDEX DIAMATIC CONCRETE TREATMENT CHEMICALS

1. ARDEX DIAMATIC FLOR-HARD™ Lithium Impregnating Densifier for ARDEX DIAMA-TOP Concrete Topping and other ARDEX Engineered Cements
 2. ARDEX DIAMATIC FLOR-FINISH™ Stain and Wear Protection Treatment (high-gloss)
 3. DIAMATIC FLOR Maintainer™ Gloss, Stain and Wear Protection Routine Maintenance Treatment
- D. ARDEX CRACK AND JOINT TREATMENT MATERIALS
1. For complete installation instructions and required tools, please refer to the individual ARDEX Technical Brochures available for each product.
 2. ARDEX ARDIBOND AP™ Fast-Setting, All-Purpose Repair Epoxy
 3. ARDEX ARDISEAL™ RAPID PLUS Semi-Rigid Joint Sealant
 4. ARDEX ARDIFIX™ Low Viscosity Rigid Polyurethane Crack and Joint Repair
- E. ARDEX MOISTURE CONTROL SYSTEM
1. Where moisture vapor emissions from new or existing concrete exceed the recommendations in Section 1.06 I above, the ARDEX MC™ ULTRA Moisture Control System shall be installed in accordance with the manufacturer's written recommendations prior to the installation of the ARDEX DIAMA-TOP. For complete installation instructions, please refer to the ARDEX MC ULTRA Technical Brochure.
- F. DIAMATIC PROTECTION MATERIALS
1. To prevent minor damage from light trade traffic during build out of site, DIAMATIC PRIMO-COVER Protective Floor Covering or DIAMATIC ECONO-COVER Protective Floor Covering for the ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System shall be installed.
 2. For other traffic considerations, please refer to section 3.09 of this specification.

2.4 MIX DESIGNS

- A. Mixing Ratio: The ARDEX DIAMA-TOP shall be mixed in 2-bag batches. Mix each bag of the powder with the specified amount of water in an ARDEX T-10 Mixing Drum using an ARDEX T-1 Mixing Paddle and a 1/2" heavy-duty drill (12 mm, min. 650 rpm). Mix thoroughly for 2-3 minutes to obtain a lump-free mixture. Follow written instructions on the ARDEX product bag label.
- B. Aggregate mix: For pre-leveling and areas to be installed over 2" (5 cm) thick, aggregate may be added to reduce material costs. Mix the powder with water first, and then add from 1 part by volume of aggregate (1/8" to 1/4" [3 to 6 mm] or larger). Do not use sand. The addition of aggregate will diminish the workability of the product and may make it necessary to install a finish layer. Allow the first layer to dry for 12 to 16 hours. Complete aggregate installation instructions are available in the ARDEX DIAMA-TOP Technical Brochure.
- C. For pump installations, the topping shall be mixed using the ARDEX Levelcraft® Automatic Mixing Pump. Start the pump at 150 gallons of water per hour, and then adjust to the minimum water reading that still allows self-leveling properties. DO NOT OVERWATER! Check the consistency of the product on the floor to ensure a uniform distribution of the sand aggregate at both the top surface and bottom of the pour. If settling occurs, reduce the water amount and recheck. Conditions during installation, such as variations in water, powder, substrate, and ambient temperature, require that the water setting be monitored and adjusted carefully to avoid over watering.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Inspect all concrete substrates and conditions under which the ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System to be installed.
- B. Verify that all surfaces and site conditions are ready to receive work; document and correct conditions detrimental to timely and proper installation of work. Beginning work constitutes acceptance of substrate condition.

- C. Verify that existing concrete has cured a minimum of 28 days before installing ARDEX DIAMA-TOP
- D. **OR** use the ARDEX MC™ ULTRA Moisture Control System for a faster track installation option.
- E. Conduct pre-installation conference, per Section 1.3 F.

3.2 PREPARATI ON

- A. All concrete surfaces must be sound, solid, cleaned and primed:
 - 1. All concrete subfloors must be of adequate strength, clean and free of all oil, grease, dirt, curing compounds and any substance that might act as a bond breaker before priming. Mechanically clean if necessary using shot blasting or other.
 - 2. The prepared concrete substrate shall have an ICRI Concrete Surface Profile of 3 (CSP #3). If additional mechanical preparation is necessary to achieve this, the concrete surface must then be swept and vacuumed to remove all loose materials.
 - 3. In all cases, chemical preparation of the substrate is NOT acceptable, including but not limited to acid etching, sweeping compounds, solvents and adhesive removers.
 - 4. All cracks in the subfloor shall be repaired using ARDEX EP 2000 or ARDEX ARDIFIX to minimize telegraphing through the concrete topping. Read and follow the detailed installation instructions as outlined in the Technical Brochures.
 - 5. Suppress dust during demolition with the use of dust collection equipment using HEPA/concrete filtration devices to reduce or eliminate airborne concrete and substrate dust.
- B. Joint Fill
 - 1. Honor all joints up through the ARDEX DIAMA-TOP, including expansion joints, isolation joints and control joints (saw cuts).
 - 2. All joint fill materials shall be installed in accordance with the written recommendations provided in the ARDEX Technical Brochures.
 - 3. All moving joints shall be filled with ARDEX ARDISEAL RAPID PLUS.
 - 4. All non-moving joints shall be filled with ARDEX ARDIBOND AP, ARDEX ARDIFIX or ARDEX ARDISEAL RAPID PLUS.
 - 5. If the joint filling will occur after the polishing process, apply ARDEX DIAMATIC FLOR-HARD, tape or soap to the edge of the ARDEX DIAMA-TOP to keep the joint filler from staining the concrete.
 - 6. Slightly overfill the joint with enough material to shave flush with the concrete. If the level of the joint filler sinks down, immediately add enough product to overfill the joint. Shave the joint filler flush with the concrete using a shaving tool with a sharp blade.
 - 7. Remove all tape and/or soap from the surface around the joint.
 - 8. MicroPolish the surface with appropriate grit DIAMATIC FLOR-GRIT pad.

3.3 PRIMING

- A. If the ARDEX MC ULTRA Moisture Control System is used, no additional priming is needed. The sand-broadcast surface of the ARDEX MC ULTRA is the primer.
- B. If ARDEX MC ULTRA is not used, the concrete shall be primed with ARDEX EP 2000.
- C. Follow the general recommendations for substrate preparation above. Apply the freshly mixed epoxy to the prepared surface using a short-nap paint roller for smoother surfaces or a longer nap for more uneven substrates. ARDEX EP 2000 can also be applied with a paintbrush for hard-to-reach areas and in corners. Primer coverage: Approximately 150-200 sq. ft. (14 to 18.6 m²)/unit.
- D. While in a fresh state, broadcast an excess of fine sand ("play sand" that is less than 1/32 of an inch in grain size) consistently over the entire area. Figure about 2/3 lb. of sand per square foot of area (0.32 kg/m²). Avoid all traffic over the surface for a minimum of 6 hours.
- E. After 16 hours, broom sweep and vacuum the surface to remove all loose sand. (Otherwise uncontaminated sand can be re-used on the next project.) Install the ARDEX DIAMA-TOP in accordance with written instructions.

3.4 ARDEX DIAMA-TOP INSTALLATION

- A. The minimum installation thickness for ARDEX DIAMA-TOP shall be 3/8" (9 mm). The necessary thickness will vary with jobsite conditions, and must be adequate to achieve the desired finish.
- B. Pour or pump the liquid topping and spread in place with the ARDEX T-4 Spreader. Use the ARDEX T-5 Smoother for featheredge and touch-up. Wear baseball shoes with non-metallic cleats to avoid leaving marks in the liquid topping. The topping can be walked on in 2-3 hours at 70°F (21°C).
- C. Allow the ARDEX DIAMA-TOP to cure a minimum of 24 to 72 hours before proceeding with the polishing process.

3.5 GLOSS ATTAINMENT (ASTM E430)

- A. Readings shall be taken not less than 10' (3 m) on center in field areas and within 1' (0.3 m) of floor area perimeters. In no case shall a reading be below 2% of specified minimum sheen:
 - 1. Level A Sheen – Low Reflectivity readings of less than 35.
 - 2. Level B Sheen – Medium Reflectivity readings of 36 to 50.
 - 3. Level C Sheen – Medium High Reflectivity readings of 51 to 65.
 - 4. Level D Sheen – High Reflectivity readings of 66 or higher.
- B. For instructions on achieving gloss levels, refer to the appropriate sub-section of section 3.04 below.

3.6 POLISHING

A. CONCRETE TOPPING POLISHING

- 1. Use the grinding and polishing steps outlines below to achieve the desired gloss level. Please note that when grinding and polishing a cross hatch pattern should be used. This process is to commence after the completion of the floor demolition, if necessary.
- 2. Level A Sheen
 - a. GRIND/POLISH #1: 60/80 Grit TROJAN Metal Bonded Diamonds.
 - b. Broom, vacuum the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #1 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum the floor as necessary to remove all residual dust.
 - f. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) Allow to dry for 16-24 hours before continuing to the next polishing step.
 - g. Apply ARDEX DIAMATIC FLOR-HARD per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - h. Allow ARDEX DIAMATIC FLOR-HARD to dry before continuing on to the next step.
 - i. GRIND/POLISH #3: 200 Grit REFINE Resin Bonded Diamonds.
 - j. Broom, vacuum the floor as necessary to remove all residual dust.
 - k. MICROPOLISH/BURNISH #1: FLOR-GRIT 400 Diamond Impregnated Pad
 - l. Dry mop the floor clean to remove all debris.
 - m. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
 - n. Allow to dry a minimum of 15 minutes.
 - o. MICROPOLISH/BURNISH #2: FLOR-GRIT 400 Diamond Impregnated Pad.
 - p. Dry mop the floor clean to remove all debris.
 - q. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).

- r. Allow to dry a minimum of 15 minutes.
 - s. MICROPOLISH/BURNISH #3: FLOR-GRIT 400 Diamond Impregnated Pad.
3. Level B Sheen
- a. GRIND/POLISH #1: 60/80 Grit TROJAN Metal Bonded Diamonds.
 - b. Broom, vacuum the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #1 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum the floor as necessary to remove all residual dust.
 - f. GRIND/POLISH #3: 200 Grit REFINE Resin Bonded Diamonds.
 - g. Broom, vacuum the floor as necessary to remove all residual dust.
 - h. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) vii. Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) Allow to dry for 16-24 hours before continuing to the next polishing step.
 - i. Apply ARDEX DIAMATIC FLOR-HARD per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - j. Allow ARDEX DIAMATIC FLOR-HARD to dry before continuing on to the next step.
 - k. GRIND/POLISH #4: 400 Grit REFINE Resin Bonded Diamonds.
 - l. Broom, vacuum the floor as necessary to remove all residual dust.
 - m. MICROPOLISH/BURNISH #1: FLOR-GRIT 400 Diamond Impregnated Pad
 - n. Dry mop the floor clean to remove all debris.
 - o. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
 - p. Allow to dry a minimum of 15 minutes.
 - q. MICROPOLISH/BURNISH #2: FLOR-GRIT 800 Diamond Impregnated Pad.
 - r. Dry mop the floor clean to remove all debris.
 - s. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
 - t. Allow to dry a minimum of 15 minutes.
 - u. MICROPOLISH/BURNISH #3: FLOR-GRIT 1500 Diamond Impregnated Pad.
4. Level C Sheen
- a. GRIND/POLISH #1: 60/80 Grit TROJAN Metal Bonded Diamonds.
 - b. Broom, vacuum the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #1 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum the floor as necessary to remove all residual dust.
 - f. GRIND/POLISH #3: 200 Grit REFINE Resin Bonded Diamonds.
 - g. Broom, vacuum the floor as necessary to remove all residual dust.
 - h. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) Allow to dry for 16-24 hours before continuing to the next polishing step.
 - i. Apply ARDEX DIAMATIC FLOR-HARD per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - j. Allow ARDEX DIAMATIC FLOR-HARD to dry before continuing on to the next step.
 - k. GRIND/POLISH #4: 400 Grit REFINE Resin Bonded Diamonds.
 - l. Broom, vacuum the floor as necessary to remove all residual dust.
 - m. GRIND/POLISH #5: 800 Grit REFINE Resin Bonded Diamonds.
 - n. Broom, vacuum the floor as necessary to remove all residual dust.
 - o. MICROPOLISH/BURNISH #1: FLOR-GRIT 800 Diamond Impregnated Pad

- p. Dry mop the floor clean to remove all debris.
 - q. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
 - r. Allow to dry a minimum of 15 minutes.
 - s. MICROPOLISH/BURNISH #2: FLOR-GRIT 1500 Diamond Impregnated Pad.
 - t. Dry mop the floor clean to remove all debris.
 - u. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
 - v. Allow to dry a minimum of 15 minutes.
 - w. MICROPOLISH/BURNISH #3: FLOR-GRIT 3000 Diamond Impregnated Pad.
5. Level C Sheen
- a. GRIND/POLISH #1: 60/80 Grit TROJAN Metal Bonded Diamonds.
 - b. Broom, vacuum the floor as necessary to remove all residual dust.
 - c. Concrete Repair Installation, as necessary.
 - d. GRIND/POLISH #2: #1 Transitional Diamonds, Ceramic Bonded.
 - e. Broom, vacuum the floor as necessary to remove all residual dust.
 - f. GRIND/POLISH #3: 200 Grit REFINE Resin Bonded Diamonds.
 - g. Broom, vacuum the floor as necessary to remove all residual dust.
 - h. If required, apply ARDEX DIAMA-FILL to concrete surface:
 - 1) Inspect concrete after the initial metal bond grind to determine if there are superficial pinholes.
 - 2) For surfaces with a large number of pinholes, mix and apply a thin fill coat of ARDEX DIAMA-FILL to a properly cleaned surface after the initial metal bond grind.
 - 3) Select the ARDEX DIAMA-FILL product from the medium gray, beige white or black color options that best match the existing concrete color.
 - 4) Allow to dry for 16-24 hours before continuing to the next polishing step.
 - i. Apply ARDEX DIAMATIC FLOR-HARD per application instructions at a rate of 400 square feet per gallon (Actual rates may vary due to concrete porosity).
 - j. Allow ARDEX DIAMATIC FLOR-HARD to dry before continuing on to the next step.
 - k. GRIND/POLISH #4: 400 Grit REFINE Resin Bonded Diamonds.
 - l. Broom, vacuum the floor as necessary to remove all residual dust.
 - m. GRIND/POLISH #5: 800 Grit REFINE Resin Bonded Diamonds.
 - n. Broom, vacuum the floor as necessary to remove all residual dust.
 - o. GRIND/POLISH #6: 1500 Grit REFINE Resin Bonded Diamonds.
 - p. Broom, vacuum the floor as necessary to remove all residual dust.
 - q. MICROPOLISH/BURNISH #1: FLOR-GRIT 1500 Diamond Impregnated Pad
 - r. Dry mop the floor clean to remove all debris.
 - s. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,000 square feet per gallon (Actual rates may vary due to concrete porosity).
 - t. Allow to dry a minimum of 15 minutes.
 - u. MICROPOLISH/BURNISH #2: FLOR-GRIT 3000 Diamond Impregnated Pad.
 - v. Dry mop the floor clean to remove all debris.
 - w. Apply ARDEX DIAMATIC FLOR-FINISH per application instructions at a rate of 2,500 square feet per gallon (Actual rates may vary due to concrete porosity).
 - x. Allow to dry a minimum of 15 minutes.
 - y. MICROPOLISH/BURNISH #3: FLOR-GRIT 3000 Diamond Impregnated Pad.

3.7 EDGES

- A. Where desired, polished edge work of ARDEX DIAMA-TOP shall be done with a 5" DIAMATIC Hand Held or Walk Behind polishing tool. The edge polishing process will match the corresponding steps outlined above for the desired gloss level, and each edge polishing step shall be done immediately before the matching main polishing step.
- B. For polishing standard concrete edges, please refer to the main specification.
- C. NOTE: All grinding and polishing completed with grinder/polisher equipment connected to a dust collector.

3.8 ACCEPTANCE

- A. Remove all installation materials, and any foreign materials resulting from the installation, from the site.
- B. Clean adjacent surfaces and materials.
- C. Perform post job walk to ensure that the ULTRAFLOOR ARDEX DIAMA-TOP Concrete System has been completed per the process spec.
- D. Take pictures of final product for documentation and submittal, if requested or required.

3.9 PROTECTION

- A. Prevent any spills or stains from coming into contact with the floor. Clean any spills that may occur as quickly as possible.
- B. Avoid moisture for 72 hours after installation. Don't permit standing water for this period or place any protective plastic sheeting, rubber matting, rugs or furniture that can prevent proper drying, thereby trapping moisture, which can result in a cloudy effect on the floor.
- C. Light pedestrian use only in the 24 hours after installation. Normal traffic recommended 14 days after completion of the ULTRAFLOOR ARDEX DIAMATIC Concrete Topping System.
- D. Protect the finished ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System from continuing construction and build out as needed by installing the DIAMATIC PRIMO-COVER Protective Floor Covering or DIAMATIC ECONO-COVER Protective Floor Covering.
 - 1. The installation of the DIAMATIC Protective Cover must be approved by the Installer and General Contractor of the ULTRAFLOOR installation.
 - 2. If the DIAMATIC Protective Cover is damaged during use, that section must be cut out and replaced to maintain the integrity of the protective covering.
 - 3. The DIAMATIC Protective Cover can be removed after build out is complete.

3.10 ONGOING MAINTENANCE

- A. **IMPORTANT NOTICE:** Maintaining the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System and adherence to a recommended cleaning schedule will help the floor hold its mechanically polished gloss longer and greatly reduces the absorption of spilled liquids. The treated concrete floor is easily maintained by regular cleaning with the Maintenance/Post Cleaning procedure, accompanied by Micro-Polishing.
- B. Newly Installed ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System
 - 1. Restrict water cleaning for 72 hours after installation of ULTRAFLOOR. Use only a dry mop to clean. Avoid putting mats or covering treated surface to allow coating to fully cure out.
 - 2. **DO NOT USE** cleaners that are acidic or that have citrus (de-limonene) or Butyl compounds. Although the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System is chemical and stain resistant, the application of these high acid cleaners may etch the surface and cause a residual stain. Regular maintenance and cleaning will help prolong surface shine.
- C. Daily Maintenance and Cleaning
 - 1. Once the system is fully cured out (min. 72 hours), routinely sweep, dry mop and wash with neutral pH cleaners or water using a mechanical auto scrubber with vacuum to pick up any residual standing water.
 - 2. **DO NOT USE** cleaners that are acidic or that have citrus (de-limonene) or Butyl compounds. Although the ULTRAFLOOR ARDEX DIAMATIC Polished Concrete System is chemical and stain resistant, the application of these high acid cleaners may etch the surface and cause a residual stain. Regular maintenance and cleaning will help prolong surface shine.
- D. Bi-Monthly or Monthly Cleaning (dependent upon floor wear and traffic)
 - 1. Follow the daily maintenance process.

2. Apply DIAMATIC FLOR-MAINTAINER diluted with parts water using a DIAMATIC CONDOR APPLICATOR or microfiber pad at a coverage rate of 8000 to 10000 square feet per gallon.
 3. Burnish/MicroPolish with DIAMATIC FLOR-GRIT 3000 diamond impregnated pad.
 4. Dry mop to remove any debris.
 5. DO NOT USE cleaners that are acidic or that have citrus (de-limonene) or Butyl compounds. Although the ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System is chemical and stain resistant, the application of these high acid cleaners may etch the surface and cause a residual stain. Regular maintenance and cleaning will help prolong surface shine.
- E. ULTRAFLOAR Rejuvenation (recommended application every 1 to 2 years depending upon floor wear and traffic)
1. Follow the daily maintenance process.
 2. Application of ARDEX DIAMATIC FLOR-FINISH applied with Condor applicator or microfiber pads. Follow manufacture application instructions.
 3. Burnish/MicroPolish with DIAMATIC FLOR-GRIT 3000 diamond impregnated pad.
 4. Dry mop to remove any debris.
 5. DO NOT USE cleaners that are acidic or that have citrus (de-limonene) or Butyl compounds. Although the ULTRAFLOAR ARDEX DIAMATIC Polished Concrete System is chemical and stain resistant, the application of these high acid cleaners may etch the surface and cause a residual stain. Regular maintenance and cleaning will help prolong surface shine.

END OF SECTION

SECTION 051200 STRUCTURAL STEEL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Structural steel framing members, welds, and fasteners.

1.2 REFERENCES

- A. AISC - Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
- B. AWS D1.1 - Code for Welding in Building Construction.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit shop drawings indicating all shop details, including sizes, spacing, and locations of structural members, connections, attachments, fasteners, and tolerances.
 - 2. Conform to AISC specifications, except provisions for Structural Engineer verification of dimensions shall not apply.
 - 3. All welds, both shop and field, shall be indicated in accordance with AWS A2.0 - Welding Symbols.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Perform Work in accordance with Chapter 22, "Steel", of the California Code of Regulations, Title 24 – Building Standards, Part 2, 2010 California Building Code (CBC).
- B. Inspection: Provide special inspection during all field welding in accordance with Code.
- C. Welder Qualifications: Welder shall be qualified by tests as prescribed in AWS Standard Qualification Procedure, B3.0-41, to perform the type of welding required. Welder shall also be LA City certified.
- D. Coordination: Provide setting drawings, templates, and directions for installation of anchor bolts and other embedded and built-in structural steel products.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver anchor bolts, base plates and other anchorage devices in time to be installed before the start of concrete operations in which products will be embedded.
- B. Storage of Materials: Store structural steel members at the project site above ground on platforms, skids or other supports. Protect steel from corrosion. Store other materials in weather-tight and dry manner, under covers which do not entrap condensation, until ready for incorporation in the Work.

1.1 PART 2 PRODUCTS

2.1 MATERIALS

- A. Structural Wide Flange Shapes: ASTM A992 OR ASTM A572 Grade 50.

- B. Structural Angles, Channels, Bars and Plates: ASTM A36.
- C. Structural Steel Pipe: ASTM A53, Grade B, Type S.
- D. Structural Steel Tubing: ASTM A500, Grade B, $F_y = 46$ ksi.
- E. Bolts and Nuts: ASTM A325-ST (Snug Tight Joint) or A325 –PT (Pre-tensioned Joint).
- F. Plain Washers: ANSI B27.2, Type B.
- G. Welding Materials: AWS D1.1, type as required for materials being welded. Provide E70XX-low hydrogen electrodes for shielded metal arc welding.

2.2 FABRICATION

- A. General: Fabricate structural steel members in accordance with AISC Specifications and CBC Chapter 22, "Steel".
- B. Shop Connections: Make welded connections in accordance with AWS D1.1.
- C. Welding shall be done in the shop unless otherwise indicated.
- D. All shop welding shall be continuously inspected, except welding performed in shop of fabricator approved by ICC, City of LA, and by the owner.
- E. Field Connections: Provide bolted connections, except where welded connections are indicated.
- F. Weld Finishing: Grind and dress smooth all welds exposed in finished Work to preserve shape and profile of welded item.

2.3 QUALITY CONTROL

- A. Tests:
 - 1. Structural steel shall be identified. The grade and ASTM specification number or designation shall be indicated on each lift or bundle of fabricated elements.
 - 2. Test specimens shall be furnished by steel fabricator and taken under direction of the Testing Laboratory to dimensions required by "Standard Methods and Definitions for Mechanical Testing of Steel Products", ASTM A370.
 - 3. Steel fabricator shall provide all labor, equipment and facilities necessary for moving and handling materials to be inspected.
- B. Welding Inspections:
 - 1. Inspection of all shop and field welding operations shall be made by a qualified Welding Inspector.
 - a. Identification marks of welders.
 - b. List of defective welds.
 - c. Manner of correction of defects.
 - 2. The Welding Inspector shall be notified at least 2 days before shop or field welding inspection is to be required.

3. The Welding Inspector shall check the material, equipment and procedures, as well as welds and competence of welder. He shall furnish a report that welding which is required to be inspected is proper and has been done in conformity with approved Drawings and Specifications.

1.2 PART 3 EXECUTION

3.1 PREPARATION

- A. Establish permanent benchmarks necessary for accurate erection of structural steel.
- B. Check elevations of concrete surfaces, and locations of anchor bolts and similar items, before erection proceeds.

3.2 ERECTION

- A. Erection, General: Erect structural steel in accordance with AISC Specifications.
- B. Bolts and Anchors: Properly place and build bolts and anchors into connecting work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate bolts and anchors accurately.
- C. Splices and Field Connections: Splice members only where indicated or with Structural Engineers written approval. Make splices and connections as indicated on Drawings.
- D. Field Cuts and Alterations: Do not field cut or alter structural members without written approval of Structural Engineer.
- E. Temporary Supports: Provide temporary bracing and supports for all dead loads of structure and the imposed loads of erection and construction activities. Maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing. Design of temporary supports shall be the sole responsibility of the Contractor.
- F. Erection Tolerances: Erect individual members in conformance with AISC Specifications to that deviations from plumb, level and true alignment shall not exceed 1 in 500.

3.3 FIELD WELDING

- A. Field Welding: Make welds by electric shielded arc process, in compliance with AWS standards. Make butt and groove welds full penetration, unless otherwise indicated.
- B. Cleaning: Upon completion, remove slag and clean welds ready for inspection and painting.
- C. Minimum Structural Weld Size: 3/16-inch by 1-1/2 inches or as indicated on Drawings.
- D. Defective Welds: Cut out defective welds with chisel.

3.4 WELDING INSPECTION

- A. Special Inspection: All field welding shall be performed under continuous inspection of a certified welding inspector from testing and inspection agency.
- B. Scope: Every layer of weld shall be inspected for quality, penetration, and conformance to design requirements.

- C. Inspection: Welding inspection shall be by gamma ray, magnaflux, trepanning, or any other aid to visual inspection considered necessary to determine quality of welding.
 - 1. When required by governing authorities having jurisdiction or by requirements notes on Drawings, perform ultrasonic testing.
 - 2. All full penetration welds shall be ultrasonic tested with a rate of reduction of tests in compliance with CBC Chapter 22.
- D. Report: Welding inspector will submit a signed report to the Structural Engineer and Inspector of Record verifying that welding was performed in compliance with specified and Code-mandated requirements and the adequate methods were used to determine the quality of the welding.
- E. Re-inspection: After correction of deficiencies in structural steel work which inspections and test reports indicate, additional inspections and test will be performed to confirm that structural steel complies with specified requirements. Costs of re-inspections will be paid in accordance with Conditions of the Contract.

END OF SECTION

SECTION 055000 METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous and ornamental metal, except structural steel framing as defined as structural steel in AISC "Code of Standard Practice".
2. Supports, anchorage and accessories for miscellaneous metal and ornamental metal work.
3. Shop prime paint on ferrous metal.
4. Steel supports for wall-hung countertops.
5. Galvanized metal (Aluminum) gratings and supports.

B. Related Sections:

1. Section 099000 – Painting: Finish painting.

1.2 REFERENCES

- A. AWS D1.1 - Structural Welding Code.
- B. SSPC PS7.01 - Steel Structures Painting Council.
- C. Specification for Design of Cold-Formed Steel Structural Members by American Iron and Steel Institute.

1.3 SUBMITTALS

- A. Comply with Section 013300.
- B. Shop Drawings: Indicate dimensions, description of materials and finishes; include plans, elevations, sections, and details of metal stairs and their connections and reactions to building structure. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections, and installation procedures, including specific requirements indicated.
 1. Indicate design criteria and reactions to structure.
 2. Construction details, sizes of metal sections, thickness of metals, profiles, attachments, dimensions and field joints, method of support from structure, and finishes.
 3. Work to be built-in or provided by other Sections.
 4. Welding: Indicate welded connections, both shop and field, using standard AWS welding symbols. Indicate net weld lengths.
 5. Provide shop drawings signed and sealed by qualified professional engineer responsible for their preparation licensed in State where project is located.
 6. Provide engineering calculations if requested.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.4 QUALITY ASSURANCE

- A. Applicable Standards: AISC "Specifications for Design of Cold-Formed Steel Structural Members" and AWS "Structural Welding Code".
- B. Qualification for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".
- C. Field Measurements: Take field measurements prior to fabrication to insure proper fitting of work.

- D. Shop Assembly: Preassemble metal items in shop to greatest extent possible, so as to minimize field splicing and assembly. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- E. Fabricator Qualifications: Firm experienced in producing metal fabrications similar to those indicated for this Project and with record of successful in-service performance, as well as sufficient production capacity to produce required units.
- F. Professional Engineer Qualifications: Professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of kind indicated. Engineering services are defined as those performed for installations of metal stairs (including handrails and railing systems) that are similar to those indicated for this Project in material, design, and extent of work.

1.5 HANDLING AND STORAGE

- A. Load, unload, handle and store work in manner that will not bend, deform or otherwise damage metal. Store so metal and shop coats will not be subject to weather or moisture, store off ground and provide covering for metal in storage.

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 MATERIALS

- A. Metal Surfaces: For fabrication of miscellaneous metal work items which will be exposed to view, use only materials which are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names and roughness. Select steel for exposed work to provide best possible appearance.
- B. Steel Plates, Shapes and Bars: ASTM A36.
- C. Steel Tubing: ASTM A501 or ASTM A500.
- D. Steel Pipe: ASTM A53, Type S, Grade A, standard weight and extra-strong as required, galvanized and plain.
- E. Galvanized Sheet Metal: ASTM A526 or A527, G-90 coating designation with both sides of metal prime painted.
- F. Galvanizing: ASTM A123, hot dip galvanizing, thickness Grade 55 unless otherwise indicated.
 - 1. Galvanize exterior steel fabrications, steel at exterior wall locations, and where steel is exposed to weather.
- G. Aluminum: 6063 Alloy tempered to strength required.
- H. Fasteners: As indicated and recommended by manufacturer. Provide zinc- coated fasteners for exterior use or where built into exterior walls.
 - 1. Provide stainless steel fasteners where indicated and where dissimilar metals are connected. Where dissimilar metals are connected, provide neoprene spacer or washer for isolation.
- I. Stainless Steel: ASTM A167, Type 304 with #4 finish. Passivate exterior stainless steel.

- J. Metal Primer Paint: Provide comparable primer recommended by finish coat manufacturer which is lead and chromate free, Low VOC complying with VOC guidelines.
 - 1. Primer for Metal to Receive High Performance Coatings (HPC): See Section 099600 for products to be applied by this Section.
 - 2. Primer to Receive Fire Protection Treatment: See applicable Division 7 Section for primer to be applied by this Section.
 - 3. Primers for Painting: See Section 099000 for primers to be applied by this Section.

2.2 FABRICATION

- A. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to radius of 1/32 inch, unless otherwise shown. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- B. Weld corners and seams continuously and in accordance with AWS. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.
- C. Form exposed connections with hairline joints which are flush and smooth, using concealed fasteners wherever possible.
- D. Fabricate and space anchoring devices to provide adequate support. Cut, reinforce, drill and tap metal work to receive finish hardware and similar items.
- E. Shop Painting: Remove scale, rust and other deleterious materials before shop coat of paint is applied. Apply shop coat of metal primer to fabricated metal items in accordance with manufacturer's printed instructions, with full coverage of joints, corners and edges.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which miscellaneous metal items are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Provide setting drawings, diagrams, templates, instructions and directions for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
- B. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items to in-place construction; including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.
- C. Perform cutting, drilling and fitting required for installation of miscellaneous metal items. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.
- D. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch up shop paint coat. Do not weld, cut or abrade surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- E. Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

- F. 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. Apply by brush or spray to provide minimum dry film thickness of 2 mils.

END OF SECTION

SECTION 061000 ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous wood framing.
2. Concealed wood blocking and nailers.
3. Subflooring,
4. Underlayment.
5. Preservative treatment.
6. Anchors nails, bolts, and screws.

B. Related Sections:

1. Section 064000 - Architectural Woodwork.
2. Section 079000 – Joint Protection.

1.2 DEFINITIONS

A. The following definitions apply to this section as they pertain to rough carpentry items.

1. Rough Carpentry: Carpentry work not specified in other Sections and not used as exposed work.

1.3 DESCRIPTION

A. Concealed wood framing, blocking, sheathing, subflooring, underlayment, anchors, fasteners, adhesives, and related items, including accessories furnished and installed as specified herein.

1.4 SUBMITTALS

A. Product Data: Submit for carpentry in accordance with Section 013300, Submittals.

1. Submit for sheathing, air infiltration barrier, vapor retarders, tapes, sealants, and miscellaneous products specified.

B. Certification:

1. Submit letter certifying that lumber is kiln-dried to 15 - 19 percent moisture content, well seasoned, grade marked, trade marked and free from warp.
2. Submit letter from treatment plant certifying that chemicals and process used and net amount of salts retained are in conformance with specified standards
3. Submit letter certifying that fire-retardant treatment materials comply with requirements herein stated and local authorities having jurisdiction and that treatment will not bleed through finished surfaces.

1.5 QUALITY ASSURANCE

A. Lumber Standard:

1. Comply with U.S. Dept. of Commerce Product Standard PS 20, including moisture content and actual sizes related to indicated nominal sizes.
2. Comply with Standard Grading Rules No. 16 for West Coast Lumber.
3. Comply with American Softwood Lumber Standard and with application grading rules of inspection agencies certified by American Lumber Standard Committee's (ALSC) Board of Review.

4. Comply with lumber producer's inspection agency grading rules certified as conforming to "National Grading Rules for Dimension Lumber" established under Section 10 of PS 20 and local code standard.
- B. Plywood Standard: Comply with U. S. Product Standard PS 1-74/ANSI A199.1; and Grades and Specifications, Performance-Rated Panels and Specifications by APA – The Engineered Wood Association local code standard. Each construction and industrial panel shall bear APA trademark and appropriate identification.
- C. Mat-Formed Particleboard: Comply with ANSI A208.1. Provide particleboard bearing NPA grade marking.
- D. Lumber: Factory-mark each piece of lumber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying agency, grade, species, moisture content at time of surfacing and mill.
 1. Seasoning: Kiln-dry lumber to 15 - 19 percent moisture content, well-seasoned, grade marked, trade marked and free from warp.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Inspect wood materials for conformance to specified grades, species, and treatment at time of delivery to Project site.
 1. Reject and return unsatisfactory wood materials.
- B. Provide facilities for handling and storage of materials to prevent damage to edges, ends and surfaces.
- C. Keep carpentry materials dry.
 1. Store lumber and plywood in stacks with provision for air circulation within stacks.
 2. Protect bottom of stacks against contact with damp surfaces. Protect exposed materials against weather.
 3. Stack materials minimum 12 inches off ground, or if on concrete slab-on-grade, minimum 1-1/2 inches, fully protected from weather.
 4. Provide for air circulation within and around stacks and under temporary coverings.
- D. Place spacers between each bundle of pressure treated materials treated with waterborne chemicals to provide air circulation.

1.7 PROJECT CONDITIONS

- A. Environmental Impact: Products containing following materials will not be permitted:
 1. Urea Formaldehyde.
 2. Chromium in wood pressure treatment products.
 3. Arsenic.

1.8 COORDINATION

- A. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit, show location of furring, nailers, blocking, grounds and similar supports to allow attachment of other work.
 1. Coordinate work directly with other subcontractors as necessary to insure proper fitting, joining or to clearances of other work. Obtain templates as required to insure proper fitting.

PART 2 PRODUCTS

2.1 LUMBER

- A. Dimension Lumber: Finished 4 sides, 15 percent maximum moisture content. Mark lumber "S-DRY".
 1. Light Framing: Construction grade Douglas Fir or Southern Pine, appearance grades where exposed.

2. Boards: Construction grade.
- B. (WD BLKG-1) Miscellaneous Lumber: 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. Wood nailers and blocking in contact with cementitious materials shall be (PPT-1) treated.
 1. Moisture content of 19 percent maximum for lumber items not specified to have wood preservative treatment.
 2. Grade: No. 3 or standard grade.

2.2 SUBFLOOR AND UNDERLAYMENT

- A. (WD SHTG-13) Subflooring: Particleboard, grade 2-M-W; 5/8 inch thickness for 16 inch span; 3/4 inch thickness for maximum 19.2 inch span.
- B. (WD SHTG-14) Underlayment: APA C-D plugged. Exposure 1, 1/2 inch square edge, fire-resistive treated Douglas Fir.
- C. (WD SHTG-15) Underlayment: APA EXT, A-C sanded (under seamless and sheet vinyl flooring).
- D. (WD SHTG-16) Underlayment: Particleboard grade 1-M-1; 1/2 inch thickness minimum. Provide grade 2-M-1 throughout damp or humid areas.

2.3 PRESERVATIVE TREATMENT

- A. Ammoniacal, or amine, copper quat ACQ: AWPA C22-92.
- B. (PPT-1) Extent of Treatment:
 1. Wood nailers and blocking in contact with cementitious materials.
 2. Plywood at parapets.
- C. Coat cut surfaces after treatment with brush coat of same preservative treatment. Allow preservative to dry prior to placing members.

2.4 ROUGH HARDWARE, FASTENERS AND ANCHORAGE DEVICES

- A. Extent: Provide rough hardware required, including nails, screws, bolts, lag screws, cinch anchors, toggle bolts, shot anchors and similar items.
 1. (Joist Hangers: Sized and profiled to suit applications, galvanized.)
- B. General: Provide proper size and type for use intended and for materials to be fastened.
 1. Install adequate hardware to insure substantial and positive anchorage.
 2. Use galvanized for exterior locations and high humidity locations and treated wood, plain finish for other interior locations.
 3. Fasteners, hangers and bearing plates used on or in connection with treated wood shall comply with IBC 2304.9.
- C. Nails: Conform to materials standards established under FS FF-N-105.
 1. At exterior work, use galvanized steel nails.
 2. Refer to IBC Nailing Schedule for quality and size.

2.5 TAPES, SEALANTS AND MISCELLANEOUS

- A. Adhesive: As recommended by manufacturer of product to be applied for surface material to give permanent adhesion, with material remaining flat to back surface. Comply with local code standards.
 1. Comply with APA AFG-01 for adhesive for use with type of construction panel indicated.
 2. Exterior: Phenolic resin waterproof glue.
 3. Interior: Water-resistant casein and other adhesives suited for particular use.

- B. Expansion Material: Dow Chemical Ethafoam. Use where expansion joint material is indicated and not installed under other sections.
- C. Concealed Sealants: Polyisobutylene sealant
 - 1. Tremco's Curtainwall Sealer.
- D. Soft Gasket or Urethane Insulation:
 - 1. Product: "Shok-Pak" flexible semi- closed cell urethane.
 - a. Distributor: Brock-White Company, Minneapolis, Minnesota.
 - 2. Provide 1/2 inch thicker than joint where foam tape, foam gasket and urethane insulation is indicated and not provided under other sections.
 - 3. Location: At gaps between framing and other materials.
- E. Sill Sealer Gaskets:
 - 1. Glass-fiber resilient insulation, fabricated in strip form for use as a sill sealer.
 - 2. Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

PART 3 EXECUTION

3.1 FRAMING, NAILERS, BUCKS, CANT STRIPS

- A. Install plumb, level, true and square to dimensions shown and required. Allow for finishes and proper clearances where necessary.
- B. Provide sound bearing, square cuts, and full bearing surfaces. Set crown up for horizontal members. Shim and block where required.
- C. Eliminate crooked, twisted, cupped or bowed framing where required.
- D. Anchorage: Adequately anchor, fasten and support members to form secure, substantial and accurate anchorage and to hold required dimensions and prevent twist.
 - 1. Use bolts and screws to eliminate loosening up of joints, sagging or similar movement.
 - 2. Use nailers for securing gravel stops, cornices, and where otherwise shown or required.

3.2 SUBFLOORING

- A. Place subflooring with end joints staggered. Secure sheets over firm bearing. Maintain surface flatness of maximum 1/8 inch in 10 feet or more.

END OF SECTION

SECTION 064000 ARCHITECTURAL WOODWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood and wood veneer cabinetwork, including:
 - a. Base cabinets, wall cabinets, wall shelving with standards and brackets.
2. Laminate clad cabinetwork, including:
 - a. Base cabinets, wall cabinets, countertops with backsplashes.
 - b. Plastic laminate wall shelving with standards and brackets.
3. Cabinet hardware and accessories.
4. Hardwood door and window trim, window stools, handrails, caps, and base.
5. Closet shelves, rods and supports.
6. Preparation of cabinetwork for utilities.
7. Prefinishing of woodwork.
8. Solid surfacing counters and window stools.

B. Related Sections:

1. Section 055000 - Metal Fabrications: Metal supports for woodwork.
2. Section 061000 - Rough Carpentry.
3. Section 079000 - Joint Protection.
4. Section 081400 - Wood Doors.
5. Section 088000 - Glazing: Sliding glass doors and glass shelves
6. Section 096500 - Resilient Flooring: Vinyl base.
7. Section 123213 - Manufactured Casework with Epoxy Countertops.
8. Division 22 – Plumbing.
9. Division 26 - Electrical.

1.2 REFERENCES

- A. AWI - Architectural Woodwork Institute, Quality Standards and Guide Specifications.

1.3 DEFINITIONS

- A. Architectural Woodwork: Custom fabricated, milled cabinetwork for specially designed units as specified under this Section.

1.4 SYSTEM DESCRIPTION

- A. Prefabricated, shop-assembled casework and custom fabricated milled cabinetwork, worksurfaces and accessories for specially designed units. Furnished and installed under single source responsibility.
- B. Custom fabricated, milled cabinetwork for specially designed units.
 1. Where custom woodwork is identified by code numbers, provide individual modular units with custom items as indicated. Where custom designed units occur in conjunction with base and upper cabinets, this Work is to be provided under this Section.
 2. Where casework is designated by code numbers, provide individual modular units as indicated, provide as single fabrication containing the features of individual modular units.

1.5 SUBMITTALS

- A. Comply with Section 013300.

- B. Shop Drawings: Indicate dimensions, descriptions of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, including specific requirements where indicated.
 - 1. Show work in related and dimensional position with sections shown in not less than 1-1/2 inch scale and details at full size.
 - 2. Indicate materials and wood species, component profiles, fastening, jointing, details, finishes and accessories.
 - 3. Indicate locations of plumbing and electrical service field conditions.
- C. Samples: Submit samples of factory finish on wood veneer and factory finish on solid wood in accordance with AWI Quality Standards Section 1500. Submit samples of finish on high pressure laminate for color and finish selection.
 - 1. Component Samples: Two sets of samples in 8 inch by 10 inch size, unless otherwise indicated, for each of the following items:
 - a. High pressure laminate for color and texture/finish selection.
 - b. Each wood veneer with shop applied finish.
 - 1) 5 inch by 24 inch.
 - c. Worksurface for color and texture/finish (other than plastic laminate).
 - d. Grommets for color.
 - e. Thermoset decorative overlays.
 - f. Hardware sample for appearance.
 - g. Work surface for appearance review.
 - 2. Unit Samples: Units may be used as part of work if approved.
 - a. Cabinetwork base (with door and drawer) without countertop.
 - b. Cabinetwork wall unit with door.
- D. Quality Assurance Submittals:
 - 1. Manufacturer/fabricator qualifications.

1.6 QUALITY ASSURANCE

- A. Quality Standards: Comply with 2003 Quality Standards of Architectural Woodwork Industry.
 - 1. Lumber: Softwood - PS-20, hardwood - FSMM-L-736C, AWI Premium Grade, species as specified. Maximum moisture content of 10 percent.
 - 2. Plywood: Softwood - PS-1/ANSI A199.1, hardwood - AWI Premium Grade species as specified.
- B. Fabricator's Qualifications: Not less than 5 years experience in the actual production of specified products.
 - 1. Previous performance by manufacturer has been satisfactory.
- C. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurement before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurement before being enclosed and indicate measurements on shop drawings.

1.7 DELIVERY, HANDLING AND STORAGE

- A. Deliver woodwork under cover.
 - 1. Do not permit delivery until project conditions, including humidity, are suitable.
- B. Except as otherwise required by relationships detailed on Drawings, do not deliver interior woodwork until building is sufficiently dry to insure no damage to woodwork will result.
 - 1. Maintain minimum relative humidity less than 50 percent; in cold weather, provide heat for at least 10 days prior to delivery.
- C. Protect woodwork items from damage, dust and dirt.

1.8 COORDINATION

- A. Coordinate work directly with other subcontractors as necessary to insure proper fitting, joining or to clearances of other work.
 - 1. Obtain templates as required to insure proper fitting.
 - 2. If required, do not install or close up areas of cabinetwork until utilities have been installed.
 - 3. Verify electrical and mechanical characteristics with other subcontractors, and exchange shop drawings.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fabricate millwork by well established and experienced firm, acceptable to Owner and Architect, with satisfactory record of similar size and quality installations.
 - 1. Architect reserves the right to reject woodwork subcontractor, if it is Architect's opinion that the following will not result in required quality within time required for completion:
 - a. Shop capacity.
 - b. Experience of workers.
 - c. Equipment or supply of material.
 - d. Previous performance by manufacturer has been unsatisfactory.

2.2 WOODWORK MATERIALS AND QUALITY GRADES

- A. Quality Standards: Materials and workmanship of woodwork shall comply with Custom Grade requirements of AWI Quality Standards, (except countertops shall comply with Premium Grade).
- B. Interior Work for Transparent Factory Finish:
 - 1. (WD-1) Species for solid hardwood: Plain sawn Red Oak (Rift Cut Oak).
 - 2. (WD-2) Species for veneered wood: Plain sliced White Oak.
 - 3. (WD-3) Species for veneered wood: American Cherry with vertical grain, transparent finish.
 - 4. (WD-4) Species for veneered wood: Select White Maple.
- C. Interior Work for Paint Finish:
 - 1. (WD-5) Species for paint finish: Natural Birch.

2.3 WOOD CABINETWORK

- A. Grade: AWI Custom Grade for transparent finish prefinishing except provide drawer fronts with vertical grain to sequence with vertical door grain unless otherwise allowed.
- B. Face construction: Provide flush type cabinetwork, unless indicated otherwise.
 - 1. Species for solid hardwood (WD-1): Plain sawn Red Oak.
 - 2. Species for veneered wood (WD-2): Plain sliced Red Oak.
 - 3. Species for semi-exposed wood veneer: Fir plywood with hardwood edge.
 - 4. Provide dust panels above compartments and drawers, except when located directly below countertops.
 - 5. Hardboard: ANSI/AHA A135.4; tempered both sides by Masonite or Weyerhaeuser. (Prefinished wood fiber hardboard with smooth faces, tempered both sides with putty color opaque polyester overlay.)
 - 6. Shelving: Plain-sliced Red Oak veneer plywood with let-in Red Oak edge.

2.4 PLASTIC LAMINATE

- A. High Pressure Decorative Laminate Quality Grade (HPDL): Comply with Custom Grade requirements of AWI Quality Standards.
 - 1. Face Construction: Provide flush type cabinetwork, unless indicated otherwise.

- B. Acceptable Manufacturers:
 - 1. Formica,
 - 2. Nevamar,
 - 3. Pionite,
 - 4. Wilson Art
- C. Plastic Laminate: NEMA LD-3, GP-50 general purpose type for horizontal applications, GP-28 for vertical applications, and PF-42 post-forming type.
 - 1. Plastic Laminate Types and Colors:
 - a. Refer to Material Identification Codes.
 - b. As selected by Architect from manufacturer's standard colors.
- D. Chemical Resistant Laminate: Chemical Resistant high pressure decorative laminate.
 - 1. Color and Pattern:
 - a. Refer to Material Identification Codes.
 - b. As selected by Architect from manufacturer's standard colors.
- E. Backing Sheet: LD-3, BK-50 backing grade, undecorated laminate, balancing sheet for where surface sheet is applied.
- F. Cabinet Liner: Thermoset decorative overlay (melamine) or .020 inch cabinet liner, 45 lb. density particleboard.
 - 1. Color: Almond, unless otherwise selected.
 - 2. (Refer to Material Identification Codes).
- G. Drawer Interiors: Melamine laminate, thermoset decorative overlay conforming to requirements of ALA, latest edition, color as selected.
- H. Cabinet Interior Shelves: Provide high pressure laminate at interior shelving in cabinetwork.
- I. Adhesive: FS MMM-A-130A. Type as recommended by laminate manufacturer and adhesive manufacturer for intended use.

2.5 CORE

- A. Coreboard: Particleboard ANSI A208.1, Grade 1-M-3.
- B. Water Resistant Coreboard: Medium density fiberboard, ANSI A208.1, ASTM D1037, Grade 2-M-2.
 - 1. Acceptable Manufacturer: Medite Corp; Exterior Medex.
 - 2. Provide water resistant coreboard for countertops with sinks.
 - 3. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde (FSC product).

2.6 EDGES

- A. Shelf, Door and Drawer Edge: 3mm PVC edge molding as selected to match.
 - 1. Wood Shelf Edge: Hardwood edge band with tongue and groove joint to shelf; miter at ends on shelves.
 - 2. Band all shelf edges.

2.7 ARCHITECTURAL CABINET TOPS

- A. Quality Standard: Comply with AWI Custom grade. Grade: GP-50 (0.050 inch nominal thickness).
- B. Plastic Laminate Top: High Pressure Decorative Plastic Laminate, clad, premium grade. Core material shall be particleboard as specified 1 inch thick, unless otherwise indicated. Provide balancing sheet on underside.
 - 1. Plastic Laminate Cladding: High pressure decorative plastic laminate complying with NEMA LD 3 and as specified herein.

- a. Colors, Patterns, and Finishes: As selected from laminate manufacturer's standard products, solid colors.
 - b. Refer to details, and Material Identification Codes for selection.
- 2. Edge Treatment: 3 mm PVC edge molding, finish as selected to match counter.
- C. Other Types of Top:
 - 1. Monolithic Solid Surface Countertops: Specified herein and refer to Material Identification Codes.
 - 2. Stainless Steel: Refer to Section 123653.
 - 3. Limestone, Architectural Grade.
 - a. Solnhofen Fleuri Greenstone, thickness indicated, by Solnhofen Natural Stone, Inc., or equal, panels with honed finish.
 - b. Refer to Material Identification Codes.

2.8 CABINET HARDWARE

A. Hinges:

- 1. (HDWR-H1) Fixed pin, five knuckle steel hinges, dull chrome, 2-3/4 inch by 0.095 thick. BHMA A156.9, B01361.
- 2. (HDWR-H2): Grass America, #3903, concealed, all metal hinges, 165 degree opening, self-closing, 3-way adjustable. Provide 3 per leaf over 48 inches high, 2 per leaf elsewhere. BHMA A 156.9 B01602.

B. Shelf Supports:

- 1. Knap & Vogt #346 NP, pin size 1/4 inch diameter by 3/8 inch long.
 - a. Provide at adjustable shelves in cabinetwork.

C. Drawer Slides: Cold rolled steel, zinc plated with positive stop and full extension. Rolling steel balls, nylon rollers by Accuride, Grass and Knap & Vogt meeting or exceeding requirements below:

- 1. (HDWR-S1): Minimum 75 lb. load rating.
- 2. (HDWR-S2): Minimum 100 lb. load rating.
- 3. (HDWR-S3): Minimum 150 lb. load rating.

D. Door and Drawer Pulls:

- 1. (HDWR-P1): 4 inch wire pull, dull chrome, by Colonial Bronze #753.
 - a. (HDWR-P2): #117.31.436 by Häfele, finish: Chrome matte.
 - b. (HDWR-P3): #106.74.906 by Häfele, finish: Aluminum Silver.
 - c. (HDWR-P4): #106.74.913 by Häfele, finish: Aluminum Silver.

E. Locks:

- 1. Disc tumbler, master-keyed, dull chrome finish by CCL Security Products #0737 and #0738.
 - a. Provide at hinged doors and drawers, where indicated.
- 2. Other Acceptable Manufacturers: CompX National, Häfele.

F. Accessories:

- 1. (BKT-1) Counter Brackets: KV 208 550 Ultimate L-Bracket series, 5mm thick steel bar with 3/4 inch steel strut, holds 1000 lb. per pair, finish in epoxy coated finish in color as indicated or selected.
- 2. (BKT-2) Work Station Brackets:
 - a. 1/8 inch steel; 1-1/2 inch forms with multiple 1/4 inch mounting holes per side; reversible; color as chosen by Architect from manufacturer's standard colors.
 - 1) Sizes as required by application: 24 inch by 29 inch, 18 inch by 24 inch, 15 inch by 21 inch (with 3 inch by 3 inch notch for wall cleat and wire run) or 8 inch by 12 inch.
 - 2) Capacity: 1,000 pounds minimum.
 - 3) Contact: A & M Hardware, Inc., Manheim, PA; 888-647-0200,
- 3. Ceiling type hook, magnetic catches, and other required hardware, as recommended by fabricator for intended use.

2.9 ADJUSTABLE SHELF STANDARDS AND BRACKETS

- A. Manufacturers: Knape & Vogt, Capitol, or Garcy.
- B. Typical Standards: K&V No. 85 with No. 185 brackets, Anachrome finish.
- C. Janitor Shelf Standards and Brackets:
 - 1. Knape & Vogt #161 heavy duty 14 inch bracket and K&V #83 standards. Provide for 3 shelves, with 9 brackets.
- D. Space standards not over 32 inches on center. Where length of standards cannot be determined from drawings, assume shelves are spaced 12 inches on center vertically, and add 12 inches to shelf spacing and furnish next larger stock size.

2.10 SOLID SURFACING

- A. Counters (SSF-1): Where indicated, provide top with coved backsplash.
 - 1. Cast polymer 1/2-inch sheet.
- B. Acceptable Manufacturers:
 - 1. Corian (and Zodiaq) by E.I. DuPont de Nemours & Company
 - 2. Avonite by Avonite, Inc.
 - 3. Formica Solid Surfacing by Formica
 - 4. Renaissance, Gibraltar and Earthstone by Wilsonart
 - 5. LG Hi-Macs by LG Solid Source, L.L.C.
- C. Pattern and Color: Standard colors and pattern as selected.
 - 1. (Refer to Material Identification Codes).
- D. Joint Adhesive: As recommended by manufacturer.

2.11 SHELVES, RODS AND SUPPORTS AND TRIM

- A. Closet Rods: Chrome rods with satin chrome finish, US26D.
- B. Closet Rod Supports: Stanley #7046 closet bar support with zinc plated finish with metal pole sockets.
 - 1. Adjustable flange bracket, Knape & Vogt, Model NO. 737.

2.12 ACCESSORIES

- A. Markerboard Panels:
 - 1. Porcelain enamel fused to 28 gauge enameling steel with ground coat both sides, finish coat of fine grain matte in white color. Laminate steel to core with waterproof cement, by Claridge Products, Neal Slate, or Mirawal.
 - a. Trim: Finish exposed trim surfaces with plastic laminate.
 - b. Color: White.
- B. Grommets:
 - 1. (GROM-1): Electric Power Cord and Telephone Cable Access Grommets: ABS Plastic grommets 1- 7/8 inches inside diameter, 2-3/8 inches overall diameter, with cap where indicated on Drawings.
 - a. Color as selected by Architect.
- C. Glass: Tempered glass as specified in Section 088000.
- D. Epoxy Resin Countertops: As specified in Section 123213.

2.13 WOODWORK FABRICATION - GENERAL

- A. Intent: It is intent of Drawings and Specifications to provide durable, serviceable millwork meeting highest standards and materials.
 - 1. Methods, construction and assembly shall meet these standards.
- B. Fabricate woodwork in accordance with reviewed shop drawings.
- C. Provisions for Work of Others: Make cutouts of proper size to accommodate other work as required by drawings or as furnished by others.
 - 1. Provide, where not otherwise indicated or concealed, moldings to cover exposed core of veneered work.
 - a. Provide proper mountings for hardware, including snuggers, catches.
- D. Provide cutouts and holes for items such as sinks, fittings, risers, ducts, and other features furnished into work of this section.
 - 1. Where it may not be practical to precut holes and where coordination with field features may be uncertain or difficult, holes and openings shall be field cut and sealed.
 - a. Sinks by Mechanical, Division 22.
- E. Woodwork Assembly: Assemble work in mill as much as possible. If necessary to insure best results, complete units shall be assembled in mill and then partially disassembled into workable sections for shipping and project installation.
 - 1. When installing items not shop assembled, distribute defects to best overall advantage allowed by specifications.
 - a. Necessary joints for shipping shall be approved type.
- F. Shop fabricate wall-mounted shelving out of plywood when spanning over 30 inches.
- G. Hardwood Veneer Paneling: Wood veneer faces will be selected to provide blueprint fabrication of panels.
 - 1. Doors that appear within areas of paneling will be made as part of sequence. If more than one flitch is used, similar flitches will be selected and break shall be made at inconspicuous point such as corner, door or window.
 - a. Joints shall be tightly spliced to avoid visible open joints. Open joints will be rejected.

2.14 PREFINISHING

- A. Finish in accordance with AWI Quality Standards Section 1500.
 - 1. Finish Grade: Premium Grade: Stain, filler, sealer and 2 top coats.
 - a. AWI System Catalyzed Polyurethane (formerly TR-6)
 - b. AWI System Conversion Varnish (formerly TR-4)
 - 2. Apply finish to achieve minimum 4 mil total dry film thickness.
- B. Factory finish as selected by Architect.

2.15 CABINETWORK FABRICATION

- A. Shop assemble cabinetwork for delivery to site in units easily handled to permit passage through building openings.
 - 1. Fabricate cabinetwork in accordance with reviewed shop drawings and AWI Custom Grade Standards.
- B. Strength: Join and assemble work to provide durable, strong, rigid units that will not warp or rack, including during shipping and installation.
- C. Gluing: Glue joints on surfaces. Use highest grade glue in strict accordance with manufacturer's recommendations.
 - 1. Use Type 1 waterproof glue for work exposed in any part of exterior, around sinks and at other locations where work is exposed to moisture or dampness that might affect glue bond.

2. Use water-resistant glue equal to urea-formaldehyde resin glue at other locations.
- D. Corners: Ease lightly with sandpaper (do not round or bevel) corners not shown rounded.
- E. Shelves: Unless noted otherwise, adjustable and 3/4 inch thick up to 36 inch span, 1 inch thick on 36 inch - 42 inch span, minimum 1-1/8 inch thick over 42 inch span.
- F. Provide screw caps for screws used to mount cabinets on walls or attach cabinets together when screws are semi-exposed.

2.16 PLASTIC LAMINATE FABRICATION

- A. Quality Grade: Workmanship of high pressure laminate shall conform to Custom Grade requirements of AWI Quality Standard.
- B. Fabrication: Apply laminate finish in full-uninterrupted sheets consistent with manufactured sizes.
1. Use cabinet liner at non-exposed surfaces, behind doors or in drawers.
 - a. Glue joints in shop, using hardwood spline, except where field joints are necessary for shipping or placing in work.
 - b. Prepare counter field joints in shop using bolt-up Tite-Joint fasteners at spacing recommended by fastener manufacturer.
 - c. Unless specifically shown otherwise, apply matching laminate to exposed edges (including back edge not tight to wall) and provide approved bevel edge at joint with face or top.
 - d. Seal core surfaces not laminate-faced with clear synthetic resin sealer recommended by laminate manufacturer.

2.17 FABRICATION OF CABINETWORK DOORS

- A. Fittings and Sizes: Trim square and factory-size to nominal opening size less approximately 1/16 inch in width and 1/8 inch in height (unless otherwise required) for final fitting.
1. Provide bottom valance on cabinets to cover under cabinet lighting where indicated, except at side of cabinet where units are gang units.
- B. Quality Grade: Except as otherwise specified herein, provide Custom Grade as defined in AWI Quality Standards.
- C. Guarantee: Cabinetwork doors shall be guaranteed for 3 years. Guaranty shall cover faulty workmanship, materials, delamination or splitting of veneers, or warp in excess of 1/4 inch. Replace doors complete including fitting, hanging, and finishing.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Installation of Woodwork shall be in accordance with AWI Quality Standards Section 1700 - Installation of Architectural Woodwork.
- B. Install free from hammer or tool marks, open joints or slivers or other defects detrimental to appearance or performance.
- C. Set plumb, level, square and true.
1. Scribe to floors and walls as required.
 - a. Miter corners, countersink nails, drill holes for nails in hardwood.
 - b. Install work after building humidity is at acceptable level.
- D. Ensure that mechanical and electrical items affecting this section are properly placed, complete, and have been inspected by Architect prior to commencement of installation.
- E. Cabinets: Install without distortion so that doors and drawers fit openings properly and are accurately aligned.

1. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation.
 - a. Complete installation of hardware and accessory items as indicated.
 - b. Maintain veneer sequence matching of cabinets with prefinish.
 2. Install screw caps where required.
- F. Tops: Anchor securely to base units and other support systems as indicated.
- G. Install solid surfacing in accordance with reviewed shop drawings and manufacturer's instructions.
- H. Adjust doors, drawers, hardware, fixtures and other moving or operating parts to function smoothly and correctly.
- I. Clean cabinetwork, counters, shelves, hardware, fittings and fixtures.

END OF SECTION

SECTION 078100 APPLIED FIREPROOFING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparation of substrates.
2. Wet-mix sprayed fireproofing.
3. Test data, literature and samples.
4. Patching and repairs.
5. Protection and cleaning.

B. Related Sections:

1. Section 078400 - Firestopping.
2. Section 078443 – Fire-Resistant Joint Sealants
3. Section 092900 - Gypsum Board.

1.2 SUBMITTALS

A. Manufacturer's Data: Submit manufacturer's specifications including certification from materials manufacturer required to show material compliance with Contract Documents.

1. Submit U. S. Department of Labor Material Safety Data Sheets (MSDS) for hazardous materials used during Work of this Section.

B. Samples: Submit to Architect for review.

1. Submit samples of cured fireproofing material, size 3-1/2 inch by 4-1/2 inch, in accordance with Section 013300.

C. Manufacturer's Certificates:

1. Certification from manufacturer, stating that proposed material is free of asbestos, including actinolite, amosite, anthophyllite, chrysotile, crocidolite, tremolite and asbestos contaminated vermiculite.
2. Certification by manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
3. Fireproofing Product Certificates: Provide certificates from fireproofing manufacturer, for each fireproofing product required, indicating that:
 - a. Steel to receive sprayed fireproofing should be unprimed; however, if it is primed, sprayed fireproofing manufacturer certify primers applied to steel in shop or field are compatible with sprayed-on fireproofing and will not impair its performance under fire exposure for applications indicated, as provided by ASTM E119 test. Include test and other data as evidence. Coordinate with structural steel Sections.
 - b. Each fireproofing product complies with specified product requirements and is suitable for use indicated.
 - c. Sprayed fireproofing has been completed in accordance with requirements to provide necessary fire resistance ratings. Provide Ratings Certificate.

D. Test Data: Submit laboratory test results for sprayed fireproofing for following, upon request.

1. Corrosion Resistance per Military Specification MIL-E-5272C and ASTM E937.
2. Deflection per ASTM E759.
3. Bond Impact per ASTM E760.
4. Compressive Strength per ASTM E761.
5. Bond Strength per ASTM E736.
6. Air Erosion per ASTM E859.
7. Surface Burning Characteristics per ASTM E84.
8. Indentation Hardness per ASTM C569.
9. Dry Density per ASTM E605.

10. Definition of Cementitious Materials - UL.

- E. Laboratory Test Reports and Engineering Studies: Submit in accordance with ASTM E119, indicating fire endurance as required to satisfy codes or other requirements. Extracts of classified listings of such tests performed by Underwriters Laboratories, Inc. (ULI) of Northbrook, Illinois, or Underwriters Laboratories of Canada (ULC) of Scarborough, Ontario, Canada, are acceptable.
1. Test results from independent testing laboratory indicating compliance of sprayed-on fireproofing products with performance requirements indicated, including asbestos content where applicable. Density requirements should be tested in accordance with the Displacement method per AWCI Tech Manual 12-A, 5.4.5.
 2. Test results of in-place performance as required under Part 3 of this Section for field quality control.

1.3 QUALITY ASSURANCES

- A. Single Source Responsibility: Obtain wet-mix sprayed-on fireproofing materials (SFRM) from single manufacturer for each different product required.
- B. Fireproofing Installer: Licensed, qualified, experienced and approved by manufacturer to apply fireproofing materials as specified. Applicator to have been in continuous business for not less than the past 5 years. Applicator shall provide, in writing, names of previous projects, comparable in type and size, successfully completed on time.
- C. Testing Agency:
1. Testing Laboratory Qualifications: Independent testing laboratory shall demonstrate to Architect's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E-699, that has experience and capability to conduct satisfactorily testing indicated without delaying progress of the Work.
 2. Perform inspection and testing to ensure that applied thickness and density meets fire rating requirements, and verify that installation meets reviewed test reports. Initial inspection and testing shall be paid for by Owner.
- D. Assemblies: Restrained and Unrestrained Assemblies Criteria for floor/ceiling and roof/ceiling assembly ratings shall comply with ANSI/UL 263. Provide fire resistance ratings for use in unrestrained conditions unless otherwise indicated.
- E. Performance Criteria:
1. Sprayed Fireproofing: Test by Underwriters' Laboratories in accordance with ASTM E119. Protect structural steel members except those encased in concrete with adequate fireproofing thickness and densities to provide fire resistance ratings as indicated.
 2. Apply materials in accordance with ASTM E84.
 3. Dry Density: Measure field density in accordance with ASTM E605 and displacement method per AWCI Tech Manual 12-A, 5.4.5. Minimum average density as listed in UL Fire Resistance Directory, ICBO Evaluation Report as required by authority having jurisdiction.
 4. Deflection: Material shall not crack, spall or delaminate from surface to which it is applied when tested in accordance with ASTM E759.
 5. Bond Impact: Material subject to impact tests in accordance with ASTM E760 shall not crack or delaminate from surface to which it is applied.
 6. Bond Strength: Fireproofing, when tested in accordance with ASTM E736, shall have minimum average bond strength of 200 psf.
 7. Air Erosion: Maximum allowable weight loss of fireproofing material of 0.005 gpm/ft² when tested in accordance with ASTM E859.
 8. Compressive Strength: Fireproofing shall not deform more than 10 percent when subjected to compressive forces of 6.9 psf when tested in accordance with ASTM E761.
 9. Corrosion Resistance: Test steel with applied fireproofing in accordance with ASTM E937; no corrosion of steel.
 10. Abrasion Resistance: No more abrasion or removal than 22 cm³ from fireproofing substrate when tested in accordance with test methods developed by city of San Francisco, Bureau of Building Inspection, and required by U.S. Navy (NAVFAC).

11. Impact Penetration: No loss of more than 6 cm³ of fireproofing material when subjected to impact penetration tests in accordance with test methods developed by City of San Francisco, Bureau of Building Inspection, and required by U.S. Navy (NAVFAC).
12. Surface Burning Characteristics ASTM E84:
 - a. Flame Spread: 0.
 - b. Smoke Development: 0.
13. Resistance to Mold: Formulate fireproofing materials (SFRM) at time of manufacturing with mold inhibitor. Test fireproofing material in accordance with ASTM G21. Material shall show resistance to mold growth when inoculated with aspergillus niger and mixed spore cultures (Tappi T487-M54 and ASTM G21).

F. Codes and Regulations:

1. Supplement this specification by applicable requirements of Building Code and authorities having jurisdiction. Refer conflicts and discrepancies between Contract Documents and ordinances to Architect's attention.

G. Reference Standards:

1. American Society for Testing and Materials (ASTM):
 - a. ASTM E84 Surface Burning Characteristics of Building Materials.
 - b. ASTM E119 Fire Tests of Building Construction and Materials.
 - c. ASTM E605 Thickness and Density of Sprayed Fire-Resistive Material Applied to Structural Members.
 - d. ASTM E736 Cohesion/Adhesion of Sprayed Fire-Resistive Material Applied to Structural Members.
 - e. ASTM E759 Effect of Deflection of Sprayed Fire-Resistive Material Applied to Structural Members.
 - f. ASTM E760 Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members.
 - g. ASTM E761 Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members.
 - h. ASTM E859 Air Erosion of Sprayed Fire-Resistive Material Applied to Structural Members.
2. Federal Specification (FS)
 - a. SS-S-111B Sound Controlling Materials (Trowel and Spray Applications).
3. Military Specification (MIL)
 - a. MIL-E-5272C Humidity Test, Procedure III.
4. International Building Code Standard (IBC)
 - a. Thickness, Density Determination and Cohesion/Adhesion For Spray-Applied Fire-Resistive Fireproofing.
5. Underwriters' Laboratories, Inc. (UL).
 - a. Building Materials Directory.
6. Occupational, Safety and Health Act (OSHA).

H. Mock-Up:

1. Apply typical sample section of not less than 10 square feet to representative substrate on site for review and to establish requirements of fire ratings and finish texture. Comply with project requirements as to thickness, density of application, and fire rating.
2. Examine installation within 24 hours of application to determine variance due to shrinkage, temperature, and humidity. Where shrinkage and cracking are evident, adjust mixture and method of application as necessary.
 - a. Provide 2 bond strength tests in accordance with ASTM E736.
 - b. Provide 2 dry density tests in accordance with ASTM E605.
 - c. Mock-up may not remain as part of work.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Package materials in sturdy moisture-proof packages and deliver to project properly marked and labeled to show manufacturer's name, brand and certification of compliance with requirements for fire hazard, fire resistance classification, date of manufacture and shelf life.

- B. Keep material dry until ready for use, off ground under cover and away from sweating walls and other damp surfaces. Discard bags that have been exposed to water or moisture. Use material before its expiration date.

1.5 PROJECT CONDITIONS

- A. Ensure structure and surface to which sprayed fireproofing is applied, is not enclosed and is open to view until application is reviewed.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply spray fireproofing when temperature of substance material and surrounding air are below manufacturer's application recommendations.

1.7 PROTECTION

- A. Provide ventilation in areas to receive fireproofing during and 24 hours after application, to maintain non-toxic, unpolluted safe work area.
- B. Protect adjacent surfaces and equipment from damage by overspray fall-out, and dusting. Mask adjacent work as required.
- C. Provide temporary enclosure to prevent spray from contaminating air.
- D. Close off and seal duct work in areas where fireproofing is applied.
- E. Protect applied sprayed fireproofing from damage.

1.8 SEQUENCING AND COORDINATION

- A. Sequence and coordinate application of sprayed-on fireproofing with other related work specified in other Sections to comply with following requirements:
 - 1. Provide temporary enclosures to prevent deterioration of sprayed-on fireproofing for interior applications due to exposure to unfavorable environmental conditions.
 - 2. Avoid unnecessary exposure of sprayed-on fireproofing to abrasion and other damage likely to occur during construction operations subsequent to its application.
 - 3. Do not apply fireproofing to metal roof decking substrates until application of roofing system has been completed; prohibit roof traffic during application and drying of fireproofing.
 - 4. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, tested, and corrections made to defective fireproofing.

1.9 WARRANTY

- A. Provide warranty stating applied fireproofing will remain free from cracks, checking, dusting, flaking, spalling, separation and blistering for minimum period of 2 years from date of Substantial Completion. Completely remove and reapply cracked fireproofing to satisfaction of Owner at no additional cost.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND PRODUCTS

- A. (FP-1): Provide standard density material meeting or exceeding 15 pounds per cubic foot per ASTM E605, no fungal growth per ASTM G21. For concealed locations and in plenum ceilings and above suspended ceilings.
 - 1. Monokote MK-6 by Grace Construction Products.
 - 2. Pyrolite 15 by Carbolite Fireproof Products Division.
 - 3. Cafco-300 by Isolotek.

4. Southwest Fireproofing Type 5GP by AD Fire Protection Systems.
- B. (FP-2): Provide medium density material meeting or exceeding 22 pounds per cubic foot per ASTM E605, no fungal growth per ASTM G21 and also containing 50 percent cement content by weight minimum. For exterior concealed areas, exposed locations on columns, beams, and roof deck in mechanical and electrical rooms, penthouses, data rooms, elevator rooms and shafts, non-ducted air shafts, equipment rooms, and other service type rooms and where indicated.
 1. Grace Construction Products, Monokote Z-106.
 2. Pyrolite 22 by Carbolite Co., Fireproofing Products Division.
 3. Carbolite Co., Fireproofing Products Div.; Pyrocrete 239.
 4. Isolatek International Corp.; Cafco 400.
 5. Pyrok-MD by Pyrok, Inc.
 6. Southwest Fireproofing Type 5MD by AD Fire Protection Systems.

2.2 MATERIALS

- A. Sprayed-on Fire-resistant Coating: Wet-mix setting based type as defined by Underwriters Laboratories and free from asbestos, actinolite, amosite, anthophyllite, chrysotile and tremolite.
 1. Wet Mix Admixtures: Materials (with and without aggregate) which, when mixed in accordance with accompanying instructions forms a slurry or mortar providing properties necessary for conveyance and application to building structures.
- B. Water: Potable, fresh and free from organic and mineral impurities which would affect set of sprayed fireproofing materials.

2.3 AUXILIARY FIREPROOFING MATERIALS

- A. Auxiliary Fireproofing Materials: Provide type compatible with sprayed-on fireproofing products and substrate that are approved for use indicated by manufacturer of sprayed-on fireproofing, and are approved by nationally recognized testing laboratories or other testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance rated designs indicated.
- B. Substrate Primers: Type approved by manufacturer of sprayed-on fireproofing for substrate and for conditions of exposure indicated.
- C. Adhesive for Bonding Fireproofing: Type recommended by manufacturer of sprayed-on fireproofing manufacturer.

2.4 MIXING

- A. Perform mixing and preparation of materials at project using mechanical equipment, in accordance with manufacturer's printed directions to achieve performance criteria specified herein.

PART 3 EXECUTION

3.1 AREA PREPARATION

- A. Provide necessary measures for protection of workers and public, as required under regulation of U.S. Occupational Safety and Health Act (OSHA), and applicable local ordinances, and code regulations.
- B. Provide protection for workmen applying fireproofing and for other workers who are in vicinity of application of mixing operations. Provide necessary measures for protection of general public and for prevention of air pollution as required. Enclose exterior openings at areas where spray application will be in progress.
- C. Provide masking, drop cloths, or other satisfactory covering for materials which are not to receive fireproofing to prevent damage from contamination from overspray or fallout of materials.

3.2 EXAMINATION

- A. Examine surfaces to which this work is to be attached or applied and notify Architect if conditions exist which are detrimental to proper and expeditious installation of work. Starting of work shall imply acceptance of substrate for adhesion and performance of work as specified. Substrate is in satisfactory condition if it complies with following :
 - 1. Substrate complies with requirements of section in which substrate and related work is specified and is free of oil, grease, rolling compounds, incomplete primers, loose mill scale, dirt or other foreign substances capable of impairing bond of fireproofing with substrate under conditions of normal use or fire exposure.
 - 2. Objects which will penetrate fireproofing, including clips, hangers, support sleeves and similar items have been securely attached to substrates.
 - 3. Substrates are not obstructed by ducts, piping, equipment and other suspended construction that could interfere with application of fireproofing and until it has dried.
- B. Cooperate with coordination and scheduling of work of this section with work of other sections so not to delay job progress.
- C. Clips, hangers, supports, sleeves and other attachments to fireproofing bases, as covered under other sections of specifications, are to be placed by other trades prior to application of fireproofing material, where these materials can be anticipated in advance.
- D. Ducts, piping or conduit or other suspended equipment that could interfere with uniform application of fireproofing material are to be positioned after application of sprayed fireproofing, unless fireproofing applicator agrees to their installation prior to fireproofing.
- E. Prior to application of fireproofing material, ascertain that steel is acceptable to receive fireproofing. Steel shall be free of oil, grease, loose mill scale, or other substance that may impair proper adhesion.

3.3 SURFACE PREPARATION

- A. Clean surface to receive sprayed fireproofing to remove mill scale, dirt, grime, oil, grease, dust, loose rust, rolling compounds, incompatible primers and other foreign material which will impair satisfactory bonding of fireproofing to substrate.
- B. Cover other work which might be damaged by fallout or overspray of fireproofing materials during application. Provide temporary enclosure as may be required to confine operations, protect environment, and to ensure adequate ambient conditions for temperature and ventilation.
- C. Notify Contractor of surface condition which cannot be corrected by normal cleaning methods and requires correction of conditions prior to application of sprayed fireproofing.

3.4 APPLICATION

- A. Commencement of application of fireproofing shall be deemed as acceptance by applicator of suitability of surface to receive work and acceptance of responsibility for failure of bond between fireproofing and substrate.
- B. Apply spray fireproofing using manufacturer's authorized installer in accordance with manufacturer's directions and instructions and in conformance with city and state codes, regulations and requirements having jurisdiction. Qualified manufacturer's representative shall be present for initial application to guide and assist applicator's personnel.
- C. Sprayed Fireproofing: Apply to areas and surfaces which are scheduled to be fireproofed and to proper thicknesses to achieve fireproofing hours.
 - 1. Control thickness of fireproofing by utilizing workable depth gauge to assure that minimum thickness has been applied.

- D. Ventilation: Make provisions to properly dry fireproofing after application. In enclosed areas lacking natural ventilation, provide mechanical air circulation and ventilation.
- E. Equipment, Mixing and Application: In accordance with manufacturer's written specification and application instructions. Mechanically control material and water ratio on project site.
- F. Qualified Personnel: Provide to supervise application.
- G. Bonding Adhesive: Apply to underside of steel roof deck units which do not have concrete topping and where required by appropriate UL Design. Bonding adhesive is optional in other conditions unless recommended by manufacturer of sprayed fire protection material (SFRM). Apply bonding adhesives in accordance with manufacturer's written application instructions.
- H. Do not install fireproofing prior to completion of concrete work on steel pan stairs. Apply to underside of roof deck assemblies only after roofing system is complete and roof traffic has ceased.
- I. Cracking: No cracking of fireproofing material allowed per UL requirements. Repair cracks at no additional cost to Owner by removing existing fireproofing and reapplying

3.5 PATCHING, REPAIRING, CLEANING AND PROTECTION

- A. Perform patching and repairing of sprayed fireproofing, due to cutting by other trades, by fireproofing applicator. Work shall be paid for by trades that performed cutting, as directed and at no additional cost.
 - 1. Coordinate installation of fireproofing with other work in order to minimize need for other trades to cut or remove fireproofing. As other trades successively complete installations of their work, maintain protection of structure's fireproofing by patching areas which have been removed or damaged prior to concealment of fireproofing by other work.
- B. After completion of fireproofing work, remove equipment and clean walls, floors, equipment, pipes and conduit of over sprayed fireproofing materials.
- C. Cleaning: Immediately upon completion of sprayed operations in each containable area, remove over-spray and fall-out materials from surfaces of other work and clean exposed surfaces to remove evidence of soiling.
- D. Cure exposed wet-mix fireproofing materials in compliance with fireproofing manufacturer's recommendations to prevent premature drying.
- E. Protect fireproofing according to advice of fireproofing manufacturer and installer from damage resulting from construction operations or other causes so that fireproofing will be without damage or deterioration at time of Substantial Completion.

3.6 FIELD QUALITY CONTROL

- A. At Owner's option Architect may select, and Owner will pay, independent testing laboratory to sample and verify thickness and density of fireproofing in accordance with provisions of ASTM E605, and cohesion/adhesion as per ASTM E736.
 - 1. Minimum testing as follows:
 - a. Randomly Selected Bay: Test each fireproofed element for thickness and density as per ASTM E605 and displacement method per AWCI Tech Manual 12-A, 5.4.5.
 - b. Randomly Selected Typical Structural Elements: Test for cohesion/adhesion as per E736.
 - c. Perform minimum of 5 tests of each kind.

- B. Contractor and sub-contractor for this Section shall cooperate with testing agency in furnishing samples for testing, and other testing agency procedures.
1. Should tested fireproofing fail to meet performance criteria, remove fireproofing, reinstall and retest at no additional cost to Owner.
 2. Correct unacceptable work and pay for further testing required to prove acceptability of installation.
 3. Patch test areas as required to re-establish fireproofing integrity.

END OF SECTION

SECTION 078400 FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Firestop joint sealant and backing, including intumescent elastomeric compounds and sealants.
2. Rigid boards, forms, wraps and accessories.
3. Fiber packing and fiber fill.
4. Wool fiber insulation and fire-safing insulation.
5. Other firestopping as indicated.

B. Related Sections:

1. Section 078100 - Applied Fireproofing.
2. Section 078443 - Fire-resistant Joint Sealants.
3. Section 079000 - Joint Protection: Other sealants.
4. Section 092900 – Gypsum Board: Acoustical sealants.
5. Divisions 13 and 14 - Firestopping of penetrations caused by special construction services is specified in Section 078400.
6. Division 21 – Fire Suppression: Firestopping of penetrations caused by fire suppression services.
7. Division 22 – Plumbing: Firestopping of penetrations caused by plumbing services.
8. Division 23 – Heating, Ventilating and Air Conditioning: Firestopping of penetrations caused by mechanical services.
9. Division 26 - Electrical: Firestopping of penetrations caused by electrical services.
10. Division 27 – Communications: Firestopping of penetrations caused by communications services.
11. Division 28 – Electronic Safety and Security: Firestopping of penetrations caused by safety and security services.

1.2 REFERENCES

- A. IEEE #634: Institute of Electrical and Electronic Engineers, Inc., Standard Cable Penetration Fire Stop Qualification Test.
- B. UL 1479: Underwriters' Laboratories, Inc. (UL), Fire Standard Test Used to Classify Products as Standard for Through-Penetration Fire Stops.
- C. UL Systems: XHEZ Series; (Pipe, conduit, cable and bus penetrations). (Table Indexes firestop systems by construction features.)
- D. UL Materials: XHHW Series; (Duct penetrations and building joints). (List of Fill, Void or Cavity materials for use in numbered firestop systems.)
- E. UL Materials, XHKU Series; (Forms and dams) (List of Forming materials for use in numbered firestop systems.)
- F. UL Assemblies: BXUV Series; (Structural floors, partitions and walls.)
- G. NFPA 101: Life Safety Code.
- H. NFPA 258: Standard Test Method for Measuring the Smoke Generated by Solid Materials.

1.3 DEFINITIONS

- A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.
- B. Barriers: Time rated fire walls, smoke barrier walls, time rated ceiling/floor assemblies and structural floors.
- C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gases, and smoke.
- D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.
- E. Construction Gaps: Gaps between adjacent sections of walls, exterior walls, and structural floors or roof decks; and gaps between adjacent sections of structural floors and at wall tops between top of wall and ceiling.
- F. System: Specific products and applications, classified and numbered by Underwriters Laboratories Inc., to close specific barrier penetrations.
- G. Sleeve: Metal fabrication or pipe section extending through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other Sections and may or may not be required.
- H. Manufacturer's Engineering Judgements: Firestopping systems which are derived from other U.L. Systems/Designs or other tests, and acceptable to the code enforcing authorities.

1.4 SYSTEM DESCRIPTION

- A. Fire Rated Construction Design Requirements: Maintain barrier fire resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and sound or vibration absorption, and at other construction gaps.
- B. Through-Penetration Fire Stopping Schedule: Assembly designs are specified generally under UL system categories by penetrating item. Manufacturers' product applications must have specific UL system designations. The schedules on the following page indicate which Series of UL Classified Through Penetration Fire Stopping (TPFS) assemblies are acceptable for this Project based on barrier type, construction and penetrant type. The TPFS Series listed are generic in nature; ex: Series C-AJ-2000 includes all designs from 2001 through 2999 from all manufacturers; note that each manufacturer has its own number for tested assemblies. The Contractor will select appropriate TPFS assemblies for each condition encountered.
- C. Refer to Schedule at the end of this section.

1.5 SUBMITTALS

- A. Product Data: Manufacturer's specifications and technical data for each material including the following.
 - 1. Composition and limitations.
 - 2. Manufacturer's installation instructions.
 - 3. Furnish sleeve size schedule indicating size of penetrating item, insulation thickness (where applicable), and minimum annular space requirements.
- B. Proposed UL System Drawings - Special Installation Drawings: Prior to starting installation of firestopping, firestopping manufacturer and installer shall review specific conditions applicable for Project, and identify each condition for firestopping and prepare individual U.L. Designs or manufacturers engineering judgements identification numbers, and installation drawings for each condition.

1. Submit 3 Special Installation Drawings for each condition, 1 set for Owner, 1 set for Architect's File Copy, and 1 set for Building Official.
 2. Submit other information as may be requested by Building Official.
- C. Submit installer qualifications for each person installing firestopping systems.

1.6 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm experienced in installation or application of systems similar in complexity to those required for this Project, plus the following.
1. Acceptable to or licensed by manufacturer, State or local authority where applicable.
 2. Not less than 2 years experience with systems.
 3. Successfully completed not less than 5 comparable scale projects using this system.
- B. Single Source Responsibility for Materials: Obtain firestopping materials from one manufacturer for entire project.
1. This does not restrict Contractor from subcontracting installation of firestopping to multiple subcontracts, but does require all installers do use the same manufacturer throughout the Project and be licensed by that manufacturer for the installation of firestopping.
- C. Field Samples: First two applications for each firestopping condition will be reviewed by Owner's Representative and the Architect, and when accepted by the local Building Official shall become a standard of performance for remaining Work.
1. Correct areas, modify method of application/installation, or adjust as directed by local code official to comply with specified requirements.
 2. Maintain field samples accessible to serve as a standard of quality for this Section.
- D. Fire-Test Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those of this specification Section:
1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, ITS, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system 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 the following:
 - 1) UL in "Fire Resistance Directory."
 - 2) ITS in "Directory of Listed Products."

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle to prevent damage, staining and disfigurement in original, new, and unopened packages and containers bearing manufacturer's name and label identifying contents. Do not freeze.
- B. Where limited shelf life of product is noted by date on container or packing list, take note and do not use out of date material.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Store firestopping materials out of weather, in cool, dry place, out of direct sunlight, at temperatures below 90 degrees F, not less than 40 degrees F and as recommended by manufacturer.
- B. Use of Foam Products: Store unmixed liquid components in original, unopened containers at temperature of 65 to 80 degrees F for 12 hours minimum before use. Use forced air ventilation in areas having less than 2 cubic feet of free air for each pound of liquid mixture being foamed.

1.9 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with fireproofing material manufacturer's recommendations for temperature and humidity conditions before, during, and after installation of fireproofing.
- B. Ventilation Requirements: Comply with fireproofing material manufacturer's recommendations during and after installation of fireproofing by natural or mechanical means.
- C. Sleeves: Unless otherwise called for, sleeves passing through walls, slabs, beams, bridging, columns, shall be minimum of 1/2 inch greater in inside diameter than external diameter of pipe passing through sleeves, or insulation diameter. Verify sleeve size required with manufacturer of firestopping used. Pipe insulation shall be continuous through sleeves. Space between sleeve and pipe or duct and annular opening space shall be provided with a firestop system. Notify Contractor immediately of deviation from above sleeving requirements.
- D. Fire Dampers: Firestopping of annular spaces around fire dampers shall be placed before installation of damper's anchoring flanges.

1.10 SEQUENCING

- A. Sequence and coordinate application of firestopping with other related work specified in other Sections to comply with the following requirements:
 - 1. Provide temporary enclosures to prevent deterioration of firestopping for interior applications due to exposure to unfavorable environmental conditions.
 - 2. Do not install enclosing or concealing construction until after firestopping has been applied, inspected, tested, and corrections have been made to any defective firestopping.

1.11 SYSTEM DESIGN

- A. Design of firestopping described by this Section is responsibility of Contractor. Individual through-penetration systems, construction-gap firestopping, through-penetration smoke-stopping, and construction-gap smoke-stopping will be selected by Contractor to meet requirements of Contract Documents and governing codes. Actual selection of individual designs or systems is responsibility of Contractor, and 'Single Source Responsibility for Materials' is required.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable manufacturers and products (FSTOP): Products listed in UL Fire Resistance Directory for UL System involved, that are manufactured by one of the following:
 - 1. 3M Fire Protection Products.
 - 2. Hilti Construction Chemicals, Inc.
 - 3. Grace Construction Products
 - 4. Nelson Firestop Products
 - 5. Rectorseal Company
 - 6. Specified Technologies Inc.
 - 7. Tremco
 - 8. US Gypsum Company

2.2 THROUGH-PENETRATION FIRESTOPPING OF FIRE RATED CONSTRUCTION

- A. Systems or devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that they conform to the construction type, penetrant type, annular space requirements, and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the product, or by the use of a separate product included as a part of the UL system or device, and designed to perform this function.

2.3 FIRESTOPPING, GENERAL

- A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 2. Temporary forming materials.
 3. Substrate primers.
 4. Collars.
 5. Steel sleeves.

2.4 FILL MATERIALS

- A. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
- B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
- F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- H. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- I. Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.

- J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- K. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - 1. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
 - 2. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.
- L. Wiring devices: Ez-Path Fire Rated Pathway by Specified Technologies, Inc.
 - 1. Fire-rated wiring devices containing intumescent material that allows cable to pass through device and adjusts automatically to cable additions or removals.
 - 2. F Rating: Equal to rating of barrier in which device is installed.
 - 3. Capable of allowing a 0 to 100-percent visual fill of cables.
 - 4. Sufficient size to accommodate quantity and size of electrical wires and data cables required.
 - 5. Provide with steel wall plates allowing for single or multiple devices to be ganged together.

2.5 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Do not allow caulks containing solvents to come in direct contact with plastic pipe.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 INSTALLATION

- A. Use methods and materials indicated in firestopping systems shown in Referenced Standards.
- B. Install penetration seal materials in accordance with instructions in UL Building Materials Directory and in accordance with manufacturer's printed instructions.
- C. Install sealant, including forming, packing and other accessory materials to fill opening around services penetrating floors and walls to provide firestops with fire resistance ratings indicated for floor or wall assembly in which penetration occurs.
 - 1. Use masking tape to protect finished substrates and products adjacent to sealant materials.
 - 2. Apply sealant as specified under Section 079200 - Joint Protection, and as recommended by sealant manufacturer; apply bead to depth of 1-1/2 inches to fill void above support, or if mineral wool support is used to depth of 1/2 inch thick. Tool sealant immediately after application and before skin forms.
 - 3. If using foam sealant, immediately after mixing, pour or inject liquid foam into penetration opening, not more than 1/3 full to compensate for expansion during cure or in strict accordance with sealant manufacturer's recommendations. Do not exceed measured snap time of foam sealant. Do not remove dams for 24 hours minimum to allow foam to fully cure.
- D. At sleeved pipes or other sleeved penetration, firestop annular space between sleeve and its contained pipe or duct with resilient firestopping sealant system to permit movement of pipe or duct without damage to firestopping sealant.
- E. Seal holes and voids made by penetrations to ensure effective fire and smoke barrier.
- F. Patch penetrations caused by cutting or presence of unused or abandoned openings or boxes using materials compatible with barrier construction and with fire rating equal to or greater than barrier rating.
- G. For plumbing sleeves, construct time rated walls after placement of penetrating materials if possible, and to fit rated construction materials tightly to or directly upon material of penetration.
- H. Large Openings: Close unused portions of large openings (annular spaces) made for later installation of pipes and ducts with solid fill equal to barrier rating or with applicable firestopping sealant system.
 - 1. Where both horizontal dimensions exceed 4 inches in structural floor openings, firestop annular spaces with concrete, or other rated assembly. Provide dowels and reinforcement, within such fill, equal to that specified for slab.
 - 2. In rated concrete or masonry wall openings where both height and width exceed thickness of rated materials, firestop annular spaces with masonry or other solid fill.
 - 3. Use fiber fill, solid fill or fiber packing to make up remainder of barrier thickness where required width of firestopping sealant system is less than barrier.
- I. Install firestopping materials capable of supporting same loading as floor at floor openings more than four inches in width without penetrating item and subject to traffic or loading.

- J. Install firestopping at least equal to barrier fire rating in and around penetrations of floor structures, exterior walls and interior walls noted as time rated fire barriers or smoke barriers.
- K. Unused or abandoned openings or boxes or penetrations caused by cutting shall be patched with materials compatible with barrier construction and with fire rating equal to or greater than barrier fire-rating.
- L. Use firestopping sealant systems at narrow spaces and at spaces with dimensions less than barrier thickness.
- M. Fill void spaces completely with firestopping material.
- N. Protect materials from damage on surfaces subject to traffic. Provide firestopping in floors flush with top of slab, sleeve or housekeeping pad.

3.5 IDENTIFICATION

- A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:

<p>Warning – Fire-stop System DO NOT DISTURB Notify Building Management of Any Damage</p> <p>Manufacturer’s System No. _____ UL System No: _____ Contractor: _____ Date Installed: _____ Manufacturer: _____</p>

3.6 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.
 - 1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.
- B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.
- C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.
- D. Manufacturer’s Field Services: Firestopping manufacturer’s technical representative shall provide the following field services during application.
 - 1. Perform a pre-installation examination and acceptance of substrate and voids scheduled for firestopping. Issue report.
 - 2. Be present at initial start-up for each process. Confirm application techniques. Issue report.
 - 3. Issue a summary report at completion of installation indicating manufacturer’s acceptance of installed system and compliance with UL Design requirements.

3.7 ADJUSTING AND CLEANING

- A. Clean up spills of liquid components.

B. Neatly cut and trim materials.

C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.8 SCHEDULE

A. See attached pages for schedule of firestopping systems

Firestopping Wall Systems

TYPE OF PENETRANT	WOOD STUDS & GYPSUM WALLBOARD UL DESIGN NO. U300 SERIES	METAL STUDS & GYPSUM WALLBOARD UL DESIGN NO. U400 SERIES	POURED CONCRETE, CONCRETE BLOCK OR MASONRY UL DESIGN NO. FOR CONCRETE BLOCK WALL U900 SERIES (ANY THICKNESS)	POURED CONCRETE CONCRETE BLOCK OR MASONRY UL DESIGN NO. FOR CONCRETE BLOCK WALL U900 SERIES GREATER THAN 8 IN.
NO PENETRANTS				
UL System Single penetrant	W-L-0000 SERIES OR NOTE 4	W-L-0000 SERIES OR NOTE 4	W-J-0000 SERIES OR NOTE 4	NOTE 4
UL System Multiple penetrants	W-L-0000 SERIES OR NOTE 4	W-L-0000 SERIES OR NOTE 4	W-J-0000 SERIES OR NOTE 4	NOTE 4
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE NONE		NONE	NONE
METALLIC, UNINSULATED PIPE, CONDUIT, OR TUBING (EXAMPLES: COPPER, IRON, STEEL)				
UL System Single penetrant	W-L-1000 SERIES	W-L-1000 SERIES	C-AJ-1000 OR W-J-1000 SERIES	C-BK-1000 OR W-K- 1000 SERIES
UL System Multiple penetrants	W-L-8000 SERIES NOTE 5	W-L-8000 SERIES NOTE 5	C-AJ-8000 OR W-J-8000 SERIES -- NOTE 5	N/A
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE NONE		NONE	NONE
NONMETALLIC, UNINSULATED PIPE, CONDUIT, OR TUBING (EXAMPLES: PVC, CPVC, GLASS)				
UL System Single penetrant	W-L-2000 SERIES	W-L-2000 SERIES	C-AJ-2000 OR W-J-2000 SERIES	C-BK-1000 OR W-K- 1000 SERIES
UL System Multiple penetrants	W-L-8000 SERIES NOTE 5	W-L-8000 SERIES NOTE 5	C-AJ-8000 OR W-J-8000 SERIES -- NOTE 5	N/A
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE NONE		NONE	NONE
ELECTRICAL CABLES				
UL System Single penetrant	W-L-3000 SERIES	W-L-3000 SERIES	C-AJ-3000 OR W-J-3000 SERIES	N/A
UL System Multiple penetrants	NONE	NONE	C-AJ-3000 OR W-J-3000 SERIES	NONE
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE NONE		NONE	NONE
CABLE TRAYS W/ELECTRICAL CABLES				

TYPE OF PENETRANT	WOOD STUDS & GYPSUM WALLBOARD UL DESIGN NO. U300 SERIES	METAL STUDS & GYPSUM WALLBOARD UL DESIGN NO. U400 SERIES	POURED CONCRETE, CONCRETE BLOCK OR MASONRY UL DESIGN NO. FOR CONCRETE BLOCK WALL U900 SERIES (ANY THICKNESS)	POURED CONCRETE CONCRETE BLOCK OR MASONRY UL DESIGN NO. FOR CONCRETE BLOCK WALL U900 SERIES GREATER THAN 8 IN.
UL System Single penetrant	W-L-4000 SERIES	W-L-4000 SERIES	C-AJ-4000 OR W-J-4000 SERIES	W-K-4000 SERIES
UL System Multiple penetrants	NONE	NONE	C-AJ-4000 OR W-J-4000 SERIES	NONE
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE NONE		NONE	NONE
INSULATED PIPES (EXAMPLES: COPPER, GLASS, IRON, PLASTIC, STEEL) IN SYSTEMS OPERATING BETWEEN 32 DEGF (0 DEGC) AND 122 DEGF (50 DEGC) (NOTE 1)				
UL System Single penetrant	W-L-5000 SERIES	W-L-5000 SERIES	C-AJ-5000 OR W-J-5000 SERIES	N/A
UL System Multiple penetrants	W-L-8000 SERIES NOTE 5	W-L-8000 SERIES NOTE 5	C-AJ-8000 OR W-J-8000 SERIES - NOTE 5	NONE
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE NONE NONE NONE			
INSULATED PIPES (EXAMPLES: COPPER, GLASS, IRON, PLASTIC, STEEL) IN SYSTEMS OPERATING BELOW 32 DEGF (0 DEGC) OR ABOVE 122 DEGF (50 DEGC) (NOTE 2)				
UL System Single penetrant	W-L-5000 SERIES	W-L-5000 SERIES	C-AJ-5000 OR W-J-5000 SERIES	N/A
UL System Multiple penetrants	W-L-8000 SERIES NOTE 5	W-L-8000 SERIES NOTE 5	C-AJ-5000 OR W-J-5000 SERIES	NONE
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NOTE 6	NOTE 6	NOTE 6	NONE
MISC ELECTRICAL PENETRATIONS (EXAMPLES: BUS DUCTS)				
UL System Single penetrant	W-L-6000 SERIES	W-L-6000 SERIES	C-AJ-6000 SERIES	N/A
UL System Multiple penetrants	N/A N/A C-AJ-6000		SERIES	NONE
F Rating	EQUAL TO BARRIER	EQUAL TO BARRIER	EQUAL TO BARRIER	EQUAL TO BARRIER

TYPE OF PENETRANT	WOOD STUDS & GYPSUM WALLBOARD UL DESIGN NO. U300 SERIES	METAL STUDS & GYPSUM WALLBOARD UL DESIGN NO. U400 SERIES	POURED CONCRETE, CONCRETE BLOCK OR MASONRY UL DESIGN NO. FOR CONCRETE BLOCK WALL U900 SERIES (ANY THICKNESS)	POURED CONCRETE CONCRETE BLOCK OR MASONRY UL DESIGN NO. FOR CONCRETE BLOCK WALL U900 SERIES GREATER THAN 8 IN.
	RATING RATING		RATING	RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE NONE NONE NONE			
METAL DUCT				
UL System Single penetrant	W-L-7000 SERIES	W-L-7000 SERIES	C-AJ-7000 OR W-J-7000 SERIES	N/A
UL System Multiple penetrants	N/A N/A N/A NONE			
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NOTE 7	NOTE 7	NOTE 7	NONE
UL LISTED ELECTRICAL BOXES				
UL System Single penetrant	CLIV OR NOTE 8	CLIV OR NOTE 8	N/A	N/A
UL System Multiple penetrants	N/A N/A N/A NONE			
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE NONE NONE NONE			
OTHER RECESSED DEVICES (NOTE 3)				
UL System Single penetrant	NOTE 8	NOTE 8	NOTE 8	NOTE 8
UL System Multiple penetrants	NONE NONE NOTE		8	NONE
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE NONE NONE NONE			

Floor Systems

TYPE OF PENETRANT	WOOD FRAMED FLOOR	POURED CONCRETE FLOOR ANY THICKNESS	POURED CONCRETE FLOOR GREATER THAN 5 INCHES
NO PENETRANTS			
UL System Single penetrant	W-L-000 SERIES OR NOTE 4	C-AJ-0000 SERIES, F-A-0000 SERIES OR NOTE 4	C-BJ-0000 SERIES OR NOTE 4
UL System Multiple penetrants	W-L-000 SERIES OR NOTE 4	NONE	NONE
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING

TYPE OF PENETRANT	WOOD FRAMED FLOOR	POURED CONCRETE FLOOR ANY THICKNESS	POURED CONCRETE FLOOR GREATER THAN 5 INCHES
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE	NONE	NONE
METALLIC, UNINSULATED PIPE, CONDUIT, OR TUBING (EXAMPLES: COPPER, IRON, STEEL)			
UL System Single penetrant	F-C-1000 SERIES	C-AJ-1000 OR F-A-1000 SERIES	C-BJ-1000 OR F-B-1000 SERIES
UL System Multiple penetrants	F-C-8000 SERIES NOTE 5	C-AJ-8000 OR F-A-8000 SERIES -- NOTE 5	C-BJ-8000 OR F-B-8000 SERIES -- NOTE 5
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE	NONE	NONE
NONMETALLIC, UNINSULATED PIPE, CONDUIT, OR TUBING (EXAMPLES: PVC, CPVC, GLASS)			
UL System Single penetrant	F-C-2000 SERIES	C-AJ-2000 OR F-A-2000 SERIES	C-BJ-2000 OR F-B-2000 SERIES
UL System Multiple penetrants	NONE	C-AJ-8000 OR F-A-8000 SERIES -- NOTE 5	C-BJ-8000 OR F-B-8000 SERIES -- NOTE 5
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE	NONE	NONE
ELECTRICAL CABLES			
UL System Single penetrant	F-C-3000 SERIES	C-AJ-3000 OR F-A-3000 SERIES	N/A
UL System Multiple penetrants	NONE NONE		NONE
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE	NONE	NONE
CABLE TRAYS W/ELECTRICAL CABLES			
UL System Single penetrant	N/A	C-AJ-4000 OR F-A-4000 SERIES	C-BJ-3000 OR F-B-3000 SERIES
UL System Multiple penetrants	NONE NONE		NONE
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE	NONE	NONE
INSULATED PIPES (EXAMPLES: COPPER, GLASS, IRON, PLASTIC, STEEL) IN SYSTEMS OPERATING BETWEEN 32 DEGF (0 DEGC) AND 122 DEGF (50 DEGC) (NOTE 1)			
UL System Single penetrant	F-C-5000 SERIES	C-AJ-5000 OR F-A-5000 SERIES	C-BJ-5000 OR F-B-5000 SERIES
UL System Multiple penetrants	F-C-8000 SERIES NOTE 5	C-AJ-8000 OR F-A-8000 SERIES - NOTE 5	C-AJ-8000 OR F-A-8000 SERIES - NOTE 5

TYPE OF PENETRANT	WOOD FRAMED FLOOR	POURED CONCRETE FLOOR ANY THICKNESS	POURED CONCRETE FLOOR GREATER THAN 5 INCHES
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE	NONE	NONE
INSULATED PIPES (EXAMPLES: COPPER, GLASS, IRON, PLASTIC, STEEL) IN SYSTEMS OPERATING BETWEEN 32 DEGF (0 DEGC) OR ABOVE 122 DEGF (50 DEGC) (NOTE 2)			
UL System Single penetrant	F-C-5000 SERIES	C-AJ-5000 OR F-A-5000 SERIES	C-AJ-5000 OR F-A-5000 SERIES
UL System Multiple penetrants	F-C-8000 SERIES NOTE 5	C-AJ-8000 OR F-A-8000 SERIES - NOTE 5	C-BJ-8000 OR F-B-8000 SERIES - NOTE 5
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NOTE 6	NOTE 6	NOTE 6
MISC ELECTRICAL PENETRATIONS (EXAMPLES: BUS DUCTS)			
UL System Single penetrant	N/A	C-AJ-6000 SERIES	C-AJ-6000 SERIES
UL System Multiple penetrants	NONE	C-AJ-8000 OR F-A-8000 SERIES - NOTE 5	C-AJ-6000 SERIES
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE	NONE	NONE
METAL DUCT			
UL System Single penetrant	F-C-7000 SERIES	C-AJ-7000 OR F-A-7000 SERIES	C-BJ-7000 OR F-B-7000 SERIES
UL System Multiple penetrants	N/A N/A		N/A
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NOTE 7	NOTE 7	NOTE 7
UL LISTED ELECTRICAL BOXES			
UL System Single penetrant	N/A N/A		N/A
UL System Multiple penetrants	N/A N/A		N/A
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE	NONE	NONE
OTHER RECESSED DEVICES (NOTE 3)			
UL System Single penetrant	NOTE 8	NOTE 8	NOTE 8
UL System Multiple penetrants	NONE NONE		NONE
F Rating	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING	EQUAL TO BARRIER RATING

TYPE OF PENETRANT	WOOD FRAMED FLOOR	POURED CONCRETE FLOOR ANY THICKNESS	POURED CONCRETE FLOOR GREATER THAN 5 INCHES
T Rating	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)	EQUAL TO F RATING (NOTE 9)
Additional Requirements	NONE	NONE	NONE

THIS SCHEDULE USES THE IDENTIFICATION SYSTEMS OF UNDERWRITERS LABORATORIES, INC. AS DEFINED IN THEIR "FIRE RESISTANCE DIRECTORY" AND AS USED BY MANUFACTURERS ON THEIR UL CLASSIFIED SYSTEM. INDICATED RATINGS MAY BE EXCEEDED. "N/A" = NOT APPLICABLE

NOTES

1. EXAMPLES OF SYSTEMS THAT OPERATE BETWEEN 32 DEG F (0 DEG C) AND 122 DEG F (50 DEG C):
 CHILLED WATER SUPPLY & RETURN
 DOMESTIC HOT WATER LESS THAN 122 DEG F (50 DEG C)
 HEAT PUMP WATER SUPPLY & RETURN
 DOMESTIC HOT WATER RECIRCULATION LESS THAN 122 DEG F (50 DEG C)
 DOMESTIC COLD WATER
2. EXAMPLES OF SYSTEMS OPERATING BELOW 32 DEG F (0 DEG C) OR ABOVE 122 DEG F (50 DEG C):
 STEAM SUPPLY & RETURN
 HEATING HOT WATER SUPPLY & RETURN
 STEAM VENT
 HOT-CHILLED WATER SUPPLY & RETURN
 CONDENSATE PUMP DISCHARGE
 GLYCOL HEATING HOT WATER SUPPLY & RETURN
 BOILER BLOW DOWN
 DOMESTIC HOT WATER SUPPLY 140 DEG F (60 DEG C)
 CRYOGENIC VENT
 DOMESTIC HOT WATER RECIRCULATION 140 DEG F (60 DEG C)
3. EXAMPLES OF OTHER RECESSED DEVICES:
 MEDICAL GAS ZONE VALVES
 UNIT HEATERS
 MEDICAL GAS OUTLETS
 FIRE FIGHTERS' PHONE
 FIRE VALVE CABINETS
 FIRE EXTINGUISHER CABINET
 FIRE HOSE CABINETS
4. SEAL OPENING USING BARRIER'S ORIGINAL CONSTRUCTION.
5. WHERE A SERIES 8000 CLASSIFIED SYSTEM IS NOT AVAILABLE, INSTALL PENETRANTS SINGLY, AND PROVIDE SINGLE-PENETRANT SYSTEMS.
6. FOR SYSTEMS THAT OPERATE BELOW 32 DEG F (0 DEG C) OR ABOVE 122 DEG F (50 DEG C), COMPLY WITH THE FOLLOWING ADDITIONAL REQUIREMENTS:
 - A. PROVIDE TPFS SYSTEM USING INTUMESCENT ELASTOMERIC WRAP STRIP AS ITS FILL, VOID, OR CAVITY MATERIAL.
 - B. DO NOT USE SERIES 8000 PENETRATIONS. PROVIDE ONLY SINGLE PENETRATIONS.
7. FOR PENETRATIONS PROTECTED WITH DAMPERS, PROVIDE TPFS SYSTEM APPROVED BY DAMPER MANUFACTURER.. WHERE UL CLASSIFIED SYSTEMS ARE NOT AVAILABLE FOR OTHER RECESSED DEVICES, MAINTAIN CONTINUITY OF RATED BARRIER CONSTRUCTION AROUND RECESS.
9. WHERE PENETRANT EXITS PENETRATION ENTIRELY WITHIN A FLOOR, PROVIDE FIRESTOP SYSTEM WITH THE SAME LEVEL OF FIRE RESISTANCE AS THE FLOOR SYSTEM. ONE SIDED COMPOSITE PANEL SYSTEMS ARE NOT ALLOWED.

END OF SECTION

SECTION 079000 JOINT PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior and interior sealants.
2. Foam gasket seals.
3. Compressible seals.

B. Related Sections:

1. Section 088000 - Glazing: Glazing sealant.
2. Section 084400 – Aluminum Curtain Walls, Windows and Entrances: Sealant in curtain wall, window and entrance system.
3. Section 092900 - Gypsum Board: Acoustical sealant at gypsum board systems.
4. Section 078400 – Firestopping.
5. Section 078443 – Fire-Resistant Joint Sealants.

1.2 SUBMITTALS

A. Comply with Section 013300, unless otherwise indicated.

B. Product Data: Manufacturer's specifications and technical data including performance, construction and fabrication.

1. Manufacturer's installation instructions for specific substrates on surface preparation and application for each type of sealant specified.
2. Indicate joint dimensions and description of sealant.

C. Color Samples: 2 sets of manufacturer's full color range for each type of sealant specified.

D. Quality Control: Comply with Section 014500.

1. Statement of qualification for manufacturers and installers.
2. Statement of compliance for compatibility of sealant with adjacent materials and coatings.
3. Field Quality Control submittals as specified in Part 3 of this Section.
 - a. Field adhesion tests.
 - b. Manufacturer's Field Services: For sizing of foam gasket seals and compressible seals.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Engage experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with record of successful in-service performance.

B. Provide materials for exterior envelope from a single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi component materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.5 PROJECT CONDITIONS

- A. Weather Conditions: Do not proceed with installation of sealant under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
 - 1. Proceed with work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength.
 - 2. Wherever joint width is affected by ambient temperature variation, apply elastomeric sealant only when temperatures are in lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.
- B. Joint Width Conditions: Do not proceed with installation of joint sealers when joint widths are less than allowed by joint sealer manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.
- D. Compatibility and Adhesion Testing: Ascertain sealant compatibility and adhesion with adjacent materials using laboratory testing procedures.

PART 2 PRODUCTS

2.1 SEALANT MATERIALS

- A. 1-Part Polyurethane Sealants: Polyurethane based one part elastomeric sealant, complying with FS-TT-S-00230C, Type II Class A, with elongation and compression of not less than 25 percent. ASTM C920, Type S, Class 25, Grade NS.
 - 1. Acceptable Manufacturers and Products:
 - a. Sika Chemical Corporation: Sikaflex-1a.
 - b. BASF Building Systems: Sonolastic NP-1.
 - c. Tremco Incorporated: Dymonic.
 - d. Pecora Corporation: Dynatrol I.
 - e. Tremco Incorporated: Vulkem 116.
- B. 2-Part Polyurethane Sealant for Horizontal Applications: Self-leveling polyurethane based 2 part elastomeric sealant, complying with FS-TT-S-00227E, Type I, Class A, with shore A hardness of not less than 30 and elongation and compression of not less than 25 percent. ASTM C920, Type M, Class 25, Grade P.
 - 1. Acceptable Manufacturers and Products:
 - a. Tremco Incorporated: THC900.
 - b. BASF Building Systems: Sonolastic SL-2.
 - c. Pecora Corporation: Urexpan NR-200.
- C. Low-Modulus Silicone Rubber Sealant: Silicone rubber based, one part neutral cure elastomeric sealant with plus 50 percent to minus 50 percent movement complying with FS-TT-S-001543, Class A, and recommended by manufacturer for joints.
 - 1. Acceptable Manufacturers and Products:
 - a. General Electric: Silpruf SCS 2000.
 - b. Dow Corning Corporation: 795 Building Sealant.
 - c. BASF Building Systems: Sonolastic Omniseal or OmniPlus.
 - d. Pecora Corporation: 864 Silicone.
 - e. Tremco Construction Division: Spectrem 3.
- D. Ultra Low-Modulus Silicone Rubber Sealant: Silicone rubber based, one part neutral cure elastomeric sealant with plus 100 percent to minus 50 percent movement complying with FS-TT-S-001543, Class A.
 - 1. Acceptable Manufacturers and Products:
 - a. Dow Corning Corporation: 790 Building Sealant.
 - b. Tremco Construction Division: Spectrem 1.

- E. Mildew-Resistant Silicone Rubber Sealant: Silicone rubber based, one part mildew resistance sealant with integral fungicide complying with FS-TT-S-001543A, Class A. Specifically recommended by manufacturer for interior joints in wet areas around plumbing fixtures and ceramic tile.
 - 1. Acceptable Manufacturers and Product:
 - a. General Electric: Sanitary 1700 Sealant.
 - b. Dow Corning Corporation: Silicone 786 mildew resistant.
 - c. Tremco Construction Division: Tremsil 600.
- F. Acrylic Sealants: General purpose, paintable acrylic-emulsion sealant. Caulk with approximately 12-1/2 percent elongation complying with ASTM C834.
 - 1. Acceptable Manufacturers and Products:
 - a. Tremco Incorporated: Acrylic Latex 834.
 - b. BASF Building Systems: Sonolac.
 - c. Pecora Corporation: AC-20.
- G. Colors: Colors as selected by Architect from manufacturer's standard colors. Acceptance of sealant will depend on range of standard colors available for selection.

2.2 FOAM GASKET SEAL

- A. Joint Design: Joint manufacturer shall review layout, configuration, and anticipated movement and establish the specific model number and size of Foam Gasket Sealant for this application.
- B. (FGS-1) Foam Gasket Seal: Pre-compressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. and impregnated with a nondrying, water-repellent agent. Factory produce in pre-compressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.
 - 1. Acceptable Manufacturers and Products:
 - a. Dayton Superior Specialty Chemicals; Polytite Standard.
 - b. EMSEAL Joint Systems, Ltd.; Emseal 25V.
 - c. Sandell Manufacturing Co., Inc.; Polyseal.
 - d. Schul International, Inc.; Sealtite.
 - e. Willseal USA, LLC; Willseal.
- C. Splice Adhesive for Foam Gasket Seal: One part urethane wet sealant as recommended by gasket seal manufacturer.

2.3 COMPRESSIBLE SEAL

- A. Joint Design: Joint manufacturer shall review layout, configuration, and anticipated movement and establish the specific model number and size of Compressible Seal for this application.
- B. Compression Seal: Wabo WA250 heavy duty neoprene seals in gray color.
 - 1. Acceptable Manufacturers and Products:
 - a. Watson Bowman Acme.
 - b. Michael Rizza Company.

2.4 ACCESSORIES

- A. Joint Primer: Non-staining type recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive type recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint Backing:
 - 1. Manufacturers and Products:
 - a. Taylor Foampack.
 - b. Denver Foam.

- c. Applied Extrusion Technology.
 - 2. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
 - 3. Cylindrical Sealant Backings: ASTM C 1330, Type C closed-cell with a surface skin. Provide Type O open-cell material only for joints not exposed to moisture only if closed cell backing cannot accommodate joint movement. Verify compatibility of joint backing with joint-sealant manufacturer for joint application indicated and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance. Use only closed cell rod at sound rated assemblies.
- D. Bond Breaker: ASTM C962, pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine joint surfaces, backing, and anchorage of units forming sealant rabbet, and conditions under which sealant work is to be performed. Do not proceed with sealant work until unsatisfactory conditions have been corrected.

3.2 JOINT SURFACE PREPARATION

- A. Clean joint surfaces immediately before installation of sealant. Remove dirt, insecure coatings, moisture and other substances which would interfere with bond of sealant.
- B. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkalinity does not interfere with sealant bond and performance. Etch with 5 percent solution of muriatic acid; neutralize with dilute ammonia solution, rinse thoroughly with water and allow to dry before sealant application.
- C. Roughen joint surfaces on vitreous coated and similar non-porous materials, wherever sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce dull sheen.
- D. Ensure that joint forming materials are compatible with sealant.
- E. Examine joint dimensions and size materials to achieve required width/depth ratios. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

3.3 SEALANT APPLICATION

- A. Apply sealant in accordance with manufacturer's printed instructions. Perform work in accordance with ASTM C804.
- B. Prime or seal joint surfaces. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.
- C. Install sealant backer rod for liquid elastomeric sealant, except where recommended to be omitted by sealant manufacturer for application shown.
- D. Install bond breaker tape wherever required by manufacturer's recommendations to ensure that elastomeric sealant will perform properly.
- E. Employ only proven installation techniques, which will ensure that sealant will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides.

1. Except as otherwise indicated, fill sealant rabbet to slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between horizontal surface and vertical surface, fill joint to form slight cove, so that joint will not trap moisture and dirt.
- F. Install sealant to depth as shown or, if not shown, as recommended by sealant manufacturer but within following general limitations, measured at center (thin) section of bead:
1. For sidewalks, pavements and similar joints sealed with elastomeric sealant and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8 inch deep nor less than 3/8 inch deep.
 2. For normal moving joints sealed with elastomeric sealant, but not subject to traffic, fill joint to depth equal to 50 percent of joint width, but not more than 1/2 inch deep nor less than 1/4 inch deep.
- G. Interior joints not subject to movement, these are:
1. Gypsum board to masonry joints.
 2. Gypsum board to hollow metal joints.
 3. Gypsum board to concrete joints.
- H. Do not allow sealant or compounds to overflow or flow onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough texture surfaces. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either primer/sealer or sealant.
- I. Remove excess and spillage of sealant promptly as work progresses. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes.
- J. Rope Wicks: Where wicks for weeping masonry cavity occur in sealant, cut wick flush with sealant face and do not seal wick ends.

3.4 FOAM GASKET SEAL INSTALLATION

- A. Comply with manufacturer's recommendations except where more stringent requirements are specified, or except where manufacturer's technical representative directs otherwise.
- B. Clean, prepare, and size joints to comply with manufacturer's recommendations. Remove loose materials and other foreign matter which might impair adhesion of sealant.
1. Size material to obtain compression of 25 percent of uncompressed dimension.
- C. Remove foam gasket from protective wrapping.
- D. Expose self-adhesive side and secure against joint face.
- E. Horizontal Joints: Proceed sequentially in one direction with scarfed ends pushed well past one another.
- F. Vertical Joints: Start at bottom and proceed up wall.
- G. Do not stretch material during installation.

3.5 COMPRESSIBLE SEAL

- A. Comply with manufacturer's recommendations except where more stringent requirements are specified, or except where manufacturer's technical representative directs otherwise.
- B. Joint Design: Joint manufacturer shall review layout, configuration, and anticipated movement and establish the specific installation of Compressible Seal for this application.

3.6 FIELD QUALITY CONTROL

- A. Sealant Adhesion Field Test: Comply with following.

1. Weathering Sealant Adhesion: After liquid-applied sealant is fully cured, perform sealant adhesion test according to sealant manufacturer's recommendations.

3.7 PROTECTION AND CLEANING

- A. Protect joint sealers during and after curing period from contact with contaminating operations or other causes so that they are without deterioration or damage at time of Substantial Completion.
 1. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.
- B. Clean off excess sealant or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.8 SCHEDULE

- A. Provide sealant where indicated (SLNT) or as required to achieve a weather-tight assembly.
- B. The following schedule is not intended to be all inclusive.
 1. Interior Joints Subject to Movement: One part polyurethane sealant.
 2. Interior Joints NOT Subject to Movement: Acrylic sealant.
 3. Interior Joints in Ceramic Tile Walls and Floors, and around Equipment and Plumbing Fixtures: Mildew resistant silicone rubber sealant.

END OF SECTION

SECTION 087100 DOOR HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Commercial door hardware for the following:
 - a. Swinging doors.
 - b. Non-fire-rated sliding doors.
 - c. Non-fire-rated folding doors.
 - d. Other doors to the extent indicated.
2. Cylinders for doors and locking devices specified in other Sections.
3. Electrified door hardware.

B. Related Sections:

1. Section 081113 – Hollow Metal Doors and Frames.
2. Section 081400 – Wood Doors.
3. Section 084113 – Aluminum-Framed Entrances and Storefronts
4. Section 087113 – Automatic Door Operators.
5. Division 26: Electrical.

1.2 GENERAL REQUIREMENTS

- A. Provide items, articles, materials, operations and methods listed, mentioned or scheduled herein or on drawings, in quantities as required to complete project. Provide hardware that functions properly. Prior to furnishing hardware, advise Architect of items that will not operate properly, are improper for conditions, or will not remain permanently anchored.
- B. All hardware shall meet the requirements of CBC Sections 1133B.2.1, 1133N.2.1, 1133B.2.5.1 and 1003.3.1.8. Thresholds shall comply with CBC Section 1133B.2.4.1.
- C. Mounting height of latching hardware shall be 30 inches to 44 inches A.F.F. per CBC Section 1133B.2.5.1. Pressure to operate the door shall not exceed: 5 lbs. (38N) for exterior doors, 5.0 lbs. (38N) for interior doors and when fire doors are required 5 lbs (38N) max or the maximum effort to operate the door may be increased to the minimum allowable by the appropriate administrative authority, not to exceed 15 lbs (66.72N). 1133B.2.5.

1.3 SUBMITTALS

- A. Hardware Schedule: Submit hardware schedule per Section 013300 in vertical format as illustrated by the Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Schedules, which do not comply, will be returned for correction before review. Hardware schedule shall clearly indicate architect's hardware group and manufacturer of each item proposed. The schedule shall be reviewed prior to submission by a certified Architectural Hardware Consultant, who shall affix his or her seal attesting to the completeness and correctness of the schedule.
1. Provide illustrations from manufacturers' catalogs and data in brochure form.
 2. Check specified hardware for suitability and adaptability to details and surrounding conditions. Indicate unsuitable or incompatible items and proposed substitutions in the hardware schedule submittal.
 3. When requested, provide listing of manufacturers' template numbers for each item of hardware in the hardware schedule submittal.

4. Furnish associated Contractors and Subcontractors with copies of final approved hardware schedule. Submit necessary templates and schedules as soon as possible to hollow metal, wood, aluminum, and other door & frame fabricators in accordance with schedule they require for fabrication.
 5. Samples: Lever design or finish sample: Provide 3 samples, if requested by architect.
- B. Closer Mounting: Indicate mounting description for each closer included in the submittal's hardware groups - i.e., push side mount (parallel arm), pull side mount (regular arm), or push side top mount (top jamb).
 - C. Electrified Hardware: Provide "operational descriptions" for each electrified hardware group in the hardware schedule submittal. Descriptions should include operation of the doors for exit, entry, and/or fire or smoke alarm conditions. Use operational descriptions included in the specified electrified groups as a guide.
 - D. Wiring Diagrams: When requested after final approval of the hardware schedule submittal, provide complete and detailed system operation and elevation riser and wiring diagrams specially developed for each opening that requires electrified hardware, except openings where only magnetic hold-opens or door position switches are specified. Provide these diagrams with hardware delivery to the jobsite.
 - E. Installation Instructions: Provide manufacturer's written installation and adjustment instructions for finish hardware. Send installation instructions to site with hardware.
 - F. Templates: Submit templates and "reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.
 - G. Contract Closeout Submittals: Comply with Section 017800 including specific requirements indicated.
 1. Operating and maintenance manuals containing the following:
 - a. Complete information in care, maintenance, and adjustment, and data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Name, address, and phone number of local representative for each manufacturer.
 - d. Parts list for each product.
 2. Copy of final approved hardware schedule, edited to reflect "As installed".
 3. Copy of final keying schedule.
 4. As installed "Wiring Diagrams" for each opening connected to power, both low voltage and 110 volts.
 5. One complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

1.4 QUALITY ASSURANCE

- A. Manufacturer: Obtain each type of hardware (ie. latch and locksets, hinges, closers) from single manufacturer, although several may be indicated as offering products complying with requirements.
- B. Supplier: Recognized architectural finish hardware supplier, with warehousing facilities, who has been providing hardware for period of not less than 3 years. The supplier shall be, or employ, a certified Architectural Hardware Consultant (AHC), who is registered in the continuing education program as administered by the Door and Hardware Institute. The hardware schedule shall be prepared and signed by a certified AHC.
- C. Installer: Firm with 3 years experience in installation of similar hardware to that required for this project, including specific requirements indicated.
- D. Regulatory Label Requirements: Provide nationally recognized testing agency label or stamp on hardware for labeled openings. Where UL requirements conflict with drawings or specifications, hardware conforming to UL requirements shall be provided. Conflicts and proposed substitutions shall be clearly indicated in hardware schedule.

- E. Accessibility Requirements: Doors to stairs (other than exit stairs), loading platforms, boiler rooms, stages and doors serving other hazardous locations shall have knurled or other similar approved marking of door lever handles or cross bars in accordance with local building codes.
- F. Pre-Installation Conference: Prior to the installation of hardware, manufacturers' representatives for locksets, closers, and exit devices shall arrange and conduct a jobsite meeting to instruct the installing contractor's personnel on the proper installation of their respective products. A letter of compliance, indicating when this meeting is held and who is in attendance, shall be sent to the Architect and Owner.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver hardware to jobsite in manufacturer's original packaging, marked to correspond with the approved hardware schedule. Do not deliver hardware until suitable locked storage space is available. Check hardware against reviewed hardware schedule. Store hardware to protect against loss, theft, or damage.
- B. Deliver hardware required to be installed during fabrication of hollow metal, aluminum, wood, or stainless steel doors prepaid to the respective manufacturer.

1.6 WARRANTY

- A. Guarantee workmanship and material provided against defective manufacture. Repair or replace defective workmanship and material appearing within period of one year after Substantial Completion.
- B. Provide a minimum ten year factory warranty on door closer body against defects in material and workmanship from date of occupancy of Project.
- C. Replace shortages and incorrect items with correct material at no additional cost to Owner.
- D. At completion of project, qualified factory representative shall inspect closer installations. After this inspection, letter shall be sent to Architect reporting on conditions, verifying that closers have been properly installed and adjusted.

PART 2 PRODUCTS

2.1 GENERAL

- A. Confirm acceptable manufacturers and models of all hardware products with Owner. Specified products are listed only to establish function and a level of quality.
- B. Specified manufacturers and models are based on the best information available at the time of this printing to establish function and level of quality, but are subject to change as additional information becomes available. Changes will be advised in future documentation.

2.2 BUTTS AND HINGES

- A. Acceptable Manufacturers and Types:

Bommer Hager		McKINNEY	PBB	Stanley
BB5024 BB1262		T4A3795	SC4B81	FBB268
BB5000	BB1279	TA2714	BB81	FBB179
BB5001/BB5002	BB1191	TA2314	BB21/BB51	FBB191
BB5004	BB1168	T4A3786	4B81	FBB168
BB5005/BB5006	BB1199	T4A3386	4B21/4B51	FBB199

- Type 1 (hvy.wt. swing clear)
- Type 2 (std.wt. ball-bearing)
- Type 3 (std.wt. rust-resistant)
- Type 4 (hvy.wt. ball-bearing)
- Type 5 (hvy.wt. rust-resistant)

- B. Application:

- 1. Exterior out-swinging doors Type 5 x NRP

2. Exterior in-swinging doors and vestibule doors Type 4
3. Interior doors with closers Type 2 or 4
4. Interior doors over 36 inches wide Type 4
5. Interior doors 36 inches or less without closer Type 2
6. Provide NRP (non-removable pins) at exterior out-swinging doors that are lockable or locked and at interior doors when specifically indicated.
7. Provide hospital tips when specifically indicated.

C. Size:

1. 2-1/4 inch Doors 5 inch by 5 inch
2. 1-3/4 inch Doors 4-1/2 inch by 4-1/2 inch
3. 1-3/8 inch Doors 3-1/3 inch by 3-1/2 inch

D. Quantity:

1. 2 – hinges per leaf for openings through 60 inches in height.
2. 1 – additional hinge per leaf for each additional 30 inches in height or fraction thereof.
3. 1 – additional hinge per leaf for openings 40 inches wide and wider.
4. 4 – hinges for Dutch doors up to 90 inches in height.
5. When hardware group assignment on opening schedule includes modifier “X”, provide additional hinge to those previously specified.

E. Drill 5/32 inch hole and use No. 12, 1-1/4 inch steel threaded to the head wood screws for hinges on wood doors.

F. Listed manufacturers and models indicate current building standards. Equivalent models by other manufacturers will be considered for Owner-approval by alternate bid and/or by written request.

2.3 FLUSH BOLTS AND DUSTPROOF STRIKES

A. Acceptable Manufacturers: Provide Trimco products as indicated below, or equivalent products by Door Controls International, Hager, or Ives.

B. Provide automatic, semi-automatic (constant/self-latching), or manual flush bolts for inactive door of pairs as indicated in the hardware group(s), and as required for metal or wood doors. Whenever bottom bolts are utilized, provide dustproof strike 3910/3910N/3911, as required for sill conditions.

1. At exterior openings provide top and bottom bolt configuration for inactive door of pair, unless indicated otherwise.
2. At interior openings that are locked or lockable, provide top and bottom bolt configuration for inactive door of pair, unless indicated otherwise.
3. At interior openings specified with a passage function, provide top bolt only, unless indicated otherwise. At fire-rated openings, provide appropriate fire bolt(s)/thermal pin(s) such as model 3850, as required by the door manufacturer to attain the specified fire-rating/label.
4. Where fully automatic flushbolts are specified in the hardware group, provide 3810/3815.
5. Where semi-automatic (or constant-latching) flushbolts are specified in the hardware group, provide model 3820/3825. Locate centerline of top bolt not more than 78 inches above finished floor – provide rod extensions as necessary.
6. Provide manual flushbolts (model 3913/3915/3916/3917/3999) or surface bolts only when specifically indicated in the assigned hardware group. Locate centerline of top bolt not more than 78 inches above finished floor – provide rod extensions as necessary.
7. At fire-rated openings utilizing top bolt only configurations, provide appropriate fire bolt(s)/thermal pin(s) (such as model 3850), as required by the door manufacturer to attain the specified fire-rating/label. Also include appropriate strike to receive bolt/pin when projected. (Dustproof type when required at floor/threshold location.)

2.4 LOCKSETS – MORTISE

A. Acceptable Manufacturer and Series:

Best Corbin	Russwin	SARGENT	Schlage	Yale
40H-15H	ML2000 x NSA	8200 x LNL	L9000 x 06A	8800FL x AUR

- B. Provide mortise locks, unless indicated otherwise, with functions specified in Hardware Groups and with following provisions:
1. Cylinders: Provide cylinders, as required, to accomplish specified lock function. (Refer to Part 2 - KEYING.)
 2. Locksets shall meet the requirements of ANSI/BHMA A156.13-1994, Operational Grade 1, and Security Grade 1.
 3. Backsets: 2-3/4 inches.
 4. Strikes: Provide wrought boxes and strikes with proper lip length to protect trim but not to project more than 1/8 inch beyond trim, frame or inactive leaf. Where required, provide open back strike and protected to allow practical and secure operation.
 5. ANSI functions – mortise locks.

Function ANSI	#
passage F01	
privacy F22	
office F04	
classroom F05	
storeroom F07	

2.5 LOCKSETS – CYLINDRICAL (HEAVY DUTY)

- A. Acceptable Manufacturer and Series:

Best Corb	Ruswin	SARGENT	Schlage	Yale
93K-15D	CL3300 x NZD	10-Line x LL	ND-RHO	5400LN x AU

- B. Provide heavy-duty cylindrical locks unless indicated otherwise with functions specified in Hardware Groups and with the following provisions:
1. Cylinders: Provide cylinders, as required, to accomplish specified lock function. (Refer to Part 2 - KEYING.)
 2. Backsets: 2-3/4 inches.
 3. Strikes: Provide wrought boxes and strikes with proper lip length to protect trim but not to project more than 1/8 inch beyond trim, frame or inactive leaf. Where required, provide open back strike and protected to allow practical and secure operation.
 4. ANSI functions – cylindrical locks.

Function ANSI	#
passage F75	
privacy F76	
office F82	
classroom F84	
storeroom F86	

2.6 KEYING

- A. Integrate keying of new locks/cylinders with existing key system as directed by Owner. (Confirm existing key system manufacturer and keyway.) Factory key all cylinders with manufacturer retaining permanent keying records. If requested, provide Owner with copy of bitting list via Owner acceptable delivery method.
- B. A keying meeting shall be scheduled to determine specific Owner and building keying requirements. Attendees shall include Owner's representative(s) and lock/cylinder manufacturer supplier and/or representative. Advise Architect and Contractor of scheduled date, time, place, and attendees.
- C. If requested, submit proposed keying schedule to Architect and meet with Owner and Architect to review schedule.
- D. Provide construction masterkeying. Permanent cylinders/cores shall be installed/activated upon completion of the project.

- E. Provide 6 masterkeys for each masterkey set. Provide 3 change keys for each lock. Stamp keys "DO NOT DUPLICATE." When interchangeable core cylinders are specified, provide 2 control keys for core removal.
- F. All keys shall be delivered to the designated Owner's representative via method determined and agreed upon by the Owner at the keying meeting.

2.7 DOOR TRIM

A. Acceptable Manufacturers and Types:

	Hiawatha	Rockwood	Trimco	
56	200H	70E	1001-9	6" x 16" push plate
54	200F	70C	1001-3	4" x 16" push plate
422	1081LBP	47	1741	1" diameter push bar
39C	658A	BF157A	1191-3	1" diameter, 10" CTC, offset pull
26C	536B	111	1195-2	1" diameter, 10" CTC, straight pull
25B	523A	107	1194-2	3/4" diameter, 8" CTC, straight pull
301/302	DES-1A/DES-2A	304/305	KE31-1/KE32-1	non-mortise edge guard
			PG8002	bottom rod & latch protector

B. Push Plates: Minimum of 0.050 inch thick, beveled 4 edges.

- 1. Hiawatha type 200H - 6 inches by 16 inches, unless otherwise indicated.
- 2. Where width of door stile prevents use of 6 inch wide plate, provide push plate one inch less than width of stile but not less than 4 inches wide.

C. Push Bars:

- 1. Hiawatha type 1081LBP, unless otherwise indicated.
- 2. Length of push bars shall be sufficient to mount each end on center of door stile. Push bars on flush doors shall be 3 inches less than door width.
- 3. Use concealed mounting and mount back-to-back with pulls.

D. Pulls:

- 1. Hiawatha Series 658A, unless otherwise indicated.
- 2. Use concealed mounting and mount back-to-back with push bars.

E. Door Protection Plates and Edge Guards:

- 1. Kick Plates and Armor Plates: Minimum of 0.050 inch thick, beveled 4 edges.
 - a. At single doors provide width 1-1/2 inches less than door width on push side. If indicated for pull side, provide 1 inch less than door width. If edge guards are specified, see edge guard paragraph below for sizing requirements.
 - b. At pairs of doors provide width 1 inch less than door width on both doors. If edge guards are specified, see edge guard paragraph below for sizing requirements.
 - c. Provide kickplate height of 10 inches and armor plate height of 34 inches, unless otherwise indicated.
- 2. Edge Guards: Minimum .050" thick, stainless steel.
 - a. Hiawatha type DES-1A/DES-2A x 34 inches high, or as noted in Hardware Groups.
 - b. When edge guards are specified in conjunction with kick and/or armor plates, coordinate widths of protection products with door widths to result in a continuous smooth surface with no more than 1/8 of an inch between the edge of the edge guard and the edge of the kick/armor plate. Overlapping of edge guards and kick/armor plates will not be permitted.
 - c. Coordinate sizing of edge guards with door & frame supplier/manufacturer to ensure that opening clearances prevent binding and/or rubbing of the swinging door.
- 3. When door protection plates and/or edge guards are specified for fire-rated openings, they shall be installed in accordance with the listing of the door. Field-installed products must be labeled and installed in accordance with manufacturers' listings.

2.8 COORDINATORS

- A. Acceptable Manufacturers: Provide Trimco products as indicated below and designated in hardware groups, or equivalent products by Door Controls International, Hager, or Ives.
- B. Provide stop-mounted coordinator (3094 series) for labeled pairs of doors equipped with automatic flush bolts and those with vertical rod/mortise lock fire exit device combinations with astragals, unless indicated otherwise.
- C. Provide filler bars for total opening width, closer mounting brackets, carry bars, and special preparation for top latches where applicable.

2.9 DOOR CLOSERS

- A. Acceptable Manufacturers and Types of Exposed Closers:

LCN Norton		SARGENT	Yale	
4040/4040 EDA	7500/PR7500	351/351-P10	4400/PR4400	heavy-duty
1460/1460 EDA	8501/PR8501	1431/1431-P10	3501/PR3501	standard-duty
1070 1600		1130	50	light-duty

- B. Provide heavy-duty non-sized closers, unless indicated otherwise in Hardware Groups, adjustable to meet maximum opening force requirements of ADA.
- C. Provide heavy-duty non-sized closers, unless standard-duty are indicated otherwise in Hardware Groups. All closers shall be adjustable to meet maximum opening force requirements of ADA.
- D. Provide heavy-duty non-sized closers, unless indicated otherwise in Hardware Groups, adjustable to meet maximum opening force requirements of ADA and CBC, and to meet the following requirements:
 - 1. Maximum opening force:
 - a. Exterior doors: 5 lbs.
 - b. Interior doors: 5 lbs.
 - c. Fire-rated doors: 15 lbs.
 - 2. Door sweep period: Minimum 3 seconds from open position of 70 degrees to a point 3 inches from latch measured to leading edge of door. (1133B2.5.1)
- E. Provide drop plates, brackets, or adapters for arms as required to suit details.
- F. Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors, unless indicated otherwise.
- G. Provide back-check for closers.
- H. Provide mechanical holder arms where indicated.
- I. Provide partial hold-open feature where indicated (holds door open at 15 degrees when room is unoccupied), similar to Norton "coupon booth" feature.
- J. Provide closers for doors as noted in Hardware Groups and, in addition, provide closers for labeled doors whether or not specifically noted in group.
- K. Provide closers meeting the requirements of UBC 7-2 and UL 10C positive pressure tests.

2.10 ELECTRONIC CLOSER/HOLDERS

- A. Acceptable Manufacturers and Types of Exposed Electronic Closer/Holders:

LCN Norton		SARGENT	Yale	
4040SE	7700PT	2408 Series	400PT	single-point
4310ME	7210MPI	2900	4210MPI	multi-point

		351EHT	
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- B. Provide non-sized closers, adjustable to meet maximum opening force requirements of ADA.
- C. Provide drop plates, brackets, or adapters for arms as required to suit details.
- D. Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- E. Provide back-check for closers.
- F. Provide single-point hold-open arms, unless indicated otherwise.
- G. Provide closer/holders meeting the requirements of UBC 7-2 and UL 10C positive pressure tests.

2.11 OVERHEAD STOPS

- A. Acceptable Manufacturers and Types:

ABH Glynn-Johnson		Rixson	SARGENT
4400	450 series	10	1540
4000	410 series	2	1530
9000	90 series	9	590
1000	100 series	1	690

standard duty, surface
 standard duty, concealed
 heavy duty, surface
 heavy duty, concealed

- B. Provide surface-mounted overhead stops for doors equipped with regular arm surface type closers that swing more than 140 degrees before striking a wall or for doors that open against equipment, casework, sidelights, or other objects that would make wall stops inappropriate. A closer stop arm is an acceptable option instead of overhead stops at interior doors with parallel arm closer mountings.
- C. Provide concealed-mounted overhead stops for doors equipped with regular arm surface type closers that swing more than 140 degrees before striking wall or for doors that open against equipment, casework, sidelights, or other objects that would make wall stops inappropriate. Provide surface-mounted overhead stops where required for fire-rated wood doors and for exterior hollow metal doors. A closer stop arm is an acceptable option instead of overhead stops at interior doors with parallel arm closer mountings.
- D. Where overhead stops are required by opening conditions, as defined above, provide heavy-duty overhead stops for doors that are over 39 inches wide and for exterior doors. A heavy-duty closer compression stop arm (equivalent to SARGENT CPS arm) is an acceptable option for overhead stops at exterior doors with parallel arm closer mountings.
- E. Provide hold-open function where indicated at non-label doors.
- F. Provide sex bolt attachments for mineral core wood door applications.

2.12 WALL STOPS AND HOLDERS

- A. Acceptable Manufacturers: Provide Ives products as indicated, or equivalent products by Burns, Hager, or Trimco.
- B. Provide wall bumper (WS407CCV) for each door leaf except where wall stops (WS11/WS11X) are specified in the Hardware Groups, or where opening conditions require the use of an overhead stop. (Refer to Part 2 – OVERHEAD STOPS)
- C. Provide overhead stop mechanism (Refer to Part 2 – OVERHEAD STOPS) for doors in which operating trim on leading/latch edge DOES NOT open against wall. Refer to degree of opening as shown on plan. Special conditions will be indicated by notes on the Opening Schedule.

- D. Provide overhead stops (Refer to Part 2 – OVERHEAD STOPS) for doors that swing more than 140 degrees before striking a wall, unless 180 degree door swing is indicated.
- E. Provide heavy-duty base stop & manual holder function (WS20/WS20X) where indicated for non-label doors.
- F. Provide heavy-duty automatic wall holder (WS45/WS45X) where indicated for non-label doors.
- G. Floor or base stops shall be used only where definitely specified or absolutely unavoidable. (If specified or utilized, install a maximum of 4 inches from a wall. Policy 99-08.)

2.13 WEATHERSTRIP AND THRESHOLDS

- A. Acceptable Manufacturers: Provide Pemko products as indicated, or equivalent products by Hager, National Guard Products, Reese Enterprises, or Zero. Refer to drawings for special details. Provide accessories, shims and fasteners.
 - 1. Provide self-tapping fasteners for products being applied to hollow metal doors and frames.
- B. Where weatherstrip and thresholds are assigned by hardware group modifier “W”, provide the following.
 - 1. Thresholds: 171A at exterior locations and 271A at interior locations, unless detailed otherwise.
 - a. Refer to drawings for special details. Provide accessories, shims and fasteners.
 - b. Where thresholds occur at openings with one or more mullions, they shall be cut for the mullions and extended continuously for the entire opening.
 - 2. Door Bottom/Sweep: 315_N, unless detailed otherwise (both doors of pairs)
 - 3. Weatherstrip: 316_V frame-applied, unless detailed otherwise
 - 4. Rain Drip: 346_ x full frame width, unless detailed otherwise
 - 5. Astragal: 18041_P split type (for each door of pairs with both doors active) or S88D gasket (applied to fixed astragal by door supplier for active/inactive pairs), unless detailed otherwise.

2.14 GASKET

- A. Acceptable Manufacturers: Provide Pemko products as indicated, or equivalent products by Hager, National Guard Products, Reese Enterprises, or Zero. Refer to drawings for special details. Provide accessories, shims and fasteners.
- B. Where smoke gasket is specified or required by fire-rating criteria, provide PK55D, unless detailed otherwise.
- C. Provide gaskets for 20-minute doors and for doors designated for smoke and draft control as required by local codes and/or door manufacturer. Also include astragal and/or gasket as required for meeting edges of pairs.
- D. Where frame-applied intumescent seals are required by the wood door manufacturer, provide gaskets that comply with UBC 7-2 and UL-10C positive-pressure testing.

2.15 SPECIAL GASKET

- A. To be completed.

2.16 MAGNETIC HOLDERS

- A. Acceptable Manufacturers and Types:

LCN	Rixson	SARGENT
SEM7830/SEM7850	FM-996 / FM-998	1560 / 1561

- B. Where magnetic holders are specified in the door schedule, provide LCN SEM7850, Rixson FM998, or SARGENT 1561, unless indicated otherwise.
 - 1. Verify voltage with Electrical.

2.17 FASTENERS

- A. Including, but not limited to; wood or machine screws, special screws, bolts, special bolts, nuts, expansion shields, anchors, and other accessory items of proper type, material, and finish required for complete operational installation of hardware.
- B. Use phillips head for exposed screws. Do not use aluminum screws to attach hardware.
- C. Provide self-tapping (TEC) screws for attachment of sweeps and stop-applied weatherstripping.

2.18 TYPICAL FINISHES AND MATERIALS

- A. Finishes, unless otherwise specified:
 - 1. Butts: Outswinging Exterior Doors
 - a. US32D (BHMA 630) on Stainless Steel
 - 2. Butts: Interior Doors and Inswinging Exterior Doors
 - a. US26D (BHMA 652) on Steel
 - 3. Continuous Geared Hinges:
 - a. US28 (BHMA 628) on Aluminum
 - 4. Continuous Stainless Steel:
 - a. US32D (BHMA 630) on Stainless Steel
 - 5. Pivots:
 - a. US26D (BHMA 626) on Brass or Bronze
 - 6. Flush Bolts:
 - a. US26D (BHMA 626) on Brass or Bronze
 - 7. Exit Devices:
 - a. US32D (BHMA 630) on Stainless Steel
 - 8. Locks and Latches:
 - a. US26D (BHMA 626) on Brass or Bronze
 - 9. Push Plates, Pulls and Push Bars:
 - a. US32D (BHMA 630) on Stainless Steel
 - 10. Coordinators:
 - a. USP (BHMA 600) on Steel
 - 11. Kick Plates, Armor Plates, and Edge Guards:
 - a. US32D (BHMA 630) on Stainless Steel
 - 12. Overhead Stops and Holders:
 - a. US26D (BHMA 626) on Brass or Bronze
 - 13. Closers: Surface mounted.
 - a. Sprayed Lacquer or Powder Coat to Match.
 - 14. Latch Protectors:
 - a. US32D (BHMA 630) on Stainless Steel
 - 15. Miscellaneous Hardware:
 - a. US26D (BHMA 626) on Brass or Bronze

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine doors, frames, and related items for conditions that would prevent the proper application of finish hardware. Do not proceed until defects are corrected.

3.2 INSTALLATION

- A. Install finish hardware in accordance with reviewed hardware schedule and manufacturer's printed instructions. Prefit hardware before finish is applied, remove and reinstall after finish is completed. Install hardware so that parts operate smoothly, close tightly and do not rattle.

- B. Installation of hardware shall comply with NFPA 80 and NFPA 101 requirements.
- C. Set units level, plumb and true to line and location. Adjust and reinforce attachment to substrate as necessary for proper installation and operation.
- D. Screws for hinges and lock fronts in wood doors shall have pilot holes pre-drilled to avoid splitting doors. Do not over-drill pilot holes or over-torque installation of screws.
- E. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- F. For doors with door pulls and push plates, Install door pulls with through bolted fasteners countersunk and flush with door face. Then install push plates over countersunk through bolts so they are concealed by push plate.
- G. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant, forming tight seal between threshold and surface to which set. Securely and permanently anchor thresholds, using countersunk non-ferrous screws to match color of thresholds (stainless steel screws at aluminum thresholds).
- H. Lead Protection: Lead wrap hardware penetrating lead-lined doors. Levers and roses to be lead lined. Apply kick and armor plates with 3M adhesive #1357, as recommended by 3M Co., on lead-lined doors.
- I. Installation of sound seals shall include the following:
 - 1. Silencers shall not be installed on doors specified with sound seals.
 - 2. Installation of sound seals shall be coordinated with all other specified and scheduled hardware.
 - 3. Sound seals shall be adjusted to provide a "light tight" seal at the entire perimeter of each door leaf.
 - 4. Closers shall be adjusted to operate as quietly as possible under normal operation.
 - 5. Apply a continuous bead of non-hardening, paintable sealant between the seal housing and door frame. Do not paint acoustic seals.
 - 6. Acoustic seals shall be continuous when installed. Do not cut seals to accommodate other hardware for any reason.

3.3 FIELD QUALITY CONTROL

- A. After installation has been completed, provide services of qualified hardware consultant to check Project to determine proper application of finish hardware according to schedule. Also check operation and adjustment of hardware items.
- B. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

3.4 ADJUSTING AND CLEANING

- A. At final completion, hardware shall be left clean and free from disfigurement. Make final adjustment to door closers and other items of hardware. Where hardware is found defective repair or replace or otherwise correct as directed.
- B. Adjust door closers to meet opening force requirements of Uniform Federal Accessibility Standards.
- C. Adjust door closers to meet opening force requirements of Uniform Federal Accessibility Standards and opening force requirements of CBC1133B.2.5.
- D. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of space or area, return to work during week prior to acceptance or occupancy, and make final check and adjustment of hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors.
- E. Instruct Owner's personnel in proper adjustment and maintenance of door hardware and hardware finishes.

F. Clean adjacent surfaces soiled by hardware installation.

3.5 PROTECTION

A. Provide for proper protection of hardware items until the Owner accepts Project as complete.

3.6 HARDWARE GROUP MODIFIERS

A. Hardware Group modifiers added to numeric hardware group assignments on the schedule of openings indicate a variation to the group as defined below.

"M" – Add mechanical holder function for non-rated doors. (both leaves of pairs) Provide holder feature for closer or for overhead stop, unless noted otherwise. Refer to Part 2 – CLOSERS and Part 2 – OVERHEAD STOPS.

NOTE: When holders are indicated at multiple occupant public restrooms, provide heavy-duty base stops & holders. Refer to Part 2 - WALL STOPS AND HOLDERS.

NOTE: When specifically indicated, provide heavy-duty automatic wall holders (Ives WS45/WS45X, or approved equivalent). Refer to Part 2 - WALL STOPS AND HOLDERS.

"S" – Provide gasket seal for jambs, head, door bottom, and meeting edges of pairs. Refer to Part 2 – SPECIAL GASKET.

NOTE: At aluminum assemblies, provide compression type bulb gasket option for jambs, head, and meeting edges (of pairs). (Brush/pile type gasket is not acceptable.)

3.7 HARDWARE GROUPS

A. Provide all required door hardware for each specified opening to comply with requirements of this section in its entirety (Parts 1, 2, and 3). Included are desired/intended functions, acceptable manufacturers and models, systems coordination, etc. for a complete installed opening.

B. Refer to the openings schedule for hardware group and modifier(s) assigned to each door opening. Ignore hardware groups and modifiers not assigned on the openings schedule.

GROUP 14 – Storeroom, no closer

Hinges

1 each Lockset Storeroom function

Function: Latchbolt is retracted by inside lever only. Outside lever is always LOCKED. Key outside retracts latchbolt. Deadlocking latchbolt.

1 each Stop (as required by opening conditions)

GROUP 33 – Classroom with closer

Hinges

1 each Lockset Classroom Function

Function: Latchbolt is retracted by lever on either side unless outside lever is locked by key. Outside key locks or unlocks outside lever. Deadlocking latchbolt.

1 each Closer

1 each Kickplate

1 each Stop (as required by opening conditions)

GROUP 43 – Classroom with closers, pair with automatic flushbolts

Hinges

1 set Flushbolts (automatic)

1 each Lockset Classroom Function
Function: Latchbolt is retracted by lever on either side unless outside lever is locked by key. Key
outside locks or unlocks outside lever. Deadlocking latchbolt.
1 each Coordinator
2 each Closers
2 each Kickplates
2 each Stops (as required by opening conditions)
Astragal (if required or indicated) is provided by Door Manufacturer/Supplier.

END OF SECTION

SECTION 088000 GLAZING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Monolithic vision glass.
 - a. Laminated glass.
 - b. Wire glass.
 - c. Tinted glass
2. Specialty glass.
 - a. Decorative (art) glass
 - b. Patterned glass
 - c. Etched glass
 - d. Leaded glass
 - e. One-way glass
3. Insulated vision glass.
 - a. Insulated laminated glass
 - b. Insulated spandrel glass.
4. Plastic glazing
5. Bullet-resistant glazing
6. Fire-rated glazing
7. Glass mirrors.
8. Accessories, glazing and setting materials.
9. Sliding glass doors with aluminum tracks.
10. Specialty glass units.
11. Self-adhered decorative film on clear glass.

B. Related Sections:

1. Section 079000 – Joint Protection.
2. Section 084113 – Aluminum Entrances and Storefronts: Glass stops and glazing gaskets.
3. Section 084229 - Automatic Entrances: Glass in automatic doors.
4. Section 084223 – Revolving Entrance Doors: Glass in revolving doors.
5. Section 085113 - Aluminum Windows: Glass in aluminum window system.
6. Section 086300 – Metal-Framed Skylights: Glass and glazing in skylights.
7. Section 084400 – Aluminum Curtain Walls, Windows and Entrances: Glass and glazing in curtain wall, window and entrance system.
8. Section 084243 – Aluminum ICU/CCU Doors: Glass in ICU/CCU doors.
9. Section 102813 – Toilet Accessories: Metal-framed mirror units.
10. Section 134900 – Radiation Protection: Lead glass.
11. Section 084114 – Aluminum Interior Doors and Frames: Glass stops and glazing gaskets.

1.2 DEFINITIONS

- A. Manufacturer: A firm that produces primary glass or fabricated glass as defined in referenced glazing publications.
- B. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
- C. Deterioration of Coated Glass: Defects developed from normal use attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

- D. Deterioration of Laminated Glass: Defects developed from normal use attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
- E. Deterioration of Insulating Glass: Failure of the hermetic seal under normal use attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Glass Design: Glass thicknesses indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites for various size openings in nominal thicknesses indicated, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
 - 1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
 - a. Specified Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour at 33 feet above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.4.2, "Analytic Procedure," based on mean roof heights above grade indicated on Drawings.
 - b. Specified Design Snow Loads: As indicated, but not less than snow loads applicable to Project, required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 7, "Snow Loads."
 - c. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
 - 1) Load Duration: 60 seconds or less.
 - d. Maximum Lateral Deflection: For the following types of glass supported on all four edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.
 - 1) For monolithic-glass lites heat treated to resist wind loads.
 - 2) For insulating glass.
 - 3) For laminated-glass lites.
 - e. Minimum Glass Thickness for Exterior Lites: Not less than 6 mm.
 - f. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.
- C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F , ambient; 180 deg F, material surfaces.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
 - 1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
 - 2. For laminated-glass lites, properties are based on products of construction indicated.
 - 3. For insulating-glass units, properties are based on units with lites 6 mm thick and a nominal 1/2-inch- wide interspace.
 - 4. Center-of-Glass U-Values: NFRC 100 methodology using LBL-35298 WINDOW 4.1 computer program, expressed as Btu/ sq. ft. x h x deg F .

5. Center-of-Glass Solar Heat Gain Coefficient: NFRC 200 methodology using LBL-35298 WINDOW 4.1 computer program.
6. Solar Optical Properties: NFRC 300

1.4 APPLICABLE STANDARDS

- A. Safety Glazing: Conform to Safety Standard for Architectural Glazing Materials (16 CFR 1201). Tempered glass and wire glass shall conform to requirements of ANSI Z97.1, with permanent label in accordance with statutes.
- B. Insulating Glass: ASTM E773, Seal Durability of Sealed Insulating Glass Units and ASTM E774, Sealed Insulating Glass Units. Certification through Insulating Glass Certification Council, Class A level.
- C. Flat Glass: ASTM C1036, Flat Glass. Flat Glass Marketing Association (FGMA) Glazing Manual.
- D. Fire-Resistance-Rated Wire Glass: Provide wire glass products that are identical to those tested per ASTM E163 (UL 9) and are labeled and listed by UL or other testing and inspecting agency acceptable to authorities having jurisdiction.
- E. Heat Treated Flat Glass: ASTM C1048, Heat Treated Flat Glass.
- F. Laminated Glass: ASTM C1172 – Standard Specification for Laminated Architectural Flat Glass; Comply with applicable quality requirements for cut sizes of flat laminated glass consisting of two or more lites of glass bonded with interlayer material for use in building glazing.

1.5 SUBMITTALS

- A. Product Data: Provide for structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
- B. Shop Drawings:
 1. Review curtain wall and window shop drawings and submit acceptance of details as suitable for proposed glass products.
 2. Submit shop drawings indicating sliding glass door tracks.
- C. Calculations: Structural design shall be performed by a Professional Engineer, licensed in the state where Project is located, per IBC Section 2403, for glass not supported on 4 sides, including glass supports and framing, indicating structural integrity of glass size, glass support members, anchors, fasteners and connections to building, in accordance with specified criteria. Signed engineering calculations shall be submitted to Architect/Engineer.
 1. Engineering Responsibility: Calculations shall be reviewed for stated design assumptions, general compliance to specified requirements, and forces imposed on glass structure. The accuracy of the design calculations shall be the sole responsibility of the Contractor's Professional Engineer.
- D. Samples: Submit samples of sandblasted/frosted, spandrel, decorative and wire glass, and glazing sealant, for color selection and appearance acceptance.
- E. Insulating Glass Certification: Submit data verifying compliance with IGCC, Class A level.
- F. Compatibility Certification: After testing and review, certify compatibility of materials in contact and in close proximity to glazing sealant materials.
- G. Wind Pressure and Thermal Stress Analysis: Submit thermal stress analysis of glass where thermal stress may occur.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association Glazier Certification Program as Level 2 (Senior Glaziers) or Level 3 (Master Glaziers).
- B. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
 - 1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
 - 2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
- C. Single Source Responsibility: Provide materials obtained from one source for each type of insulating glass and glazing product indicated.
- D. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252
- E. Fire-Rated Window Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
- F. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201 and ANSI Z97.1.
 - 1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
- G. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following inspecting and testing agency:
 - 1. Insulating Glass Certification Council.
- H. Mockups: Before glazing, build mockups for each glass product indicated below to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups in the combination with curtain wall mockup requirements.
 - 2. Build mockups with the glass to match glazing systems required for Project, including typical lite size, framing systems, and glazing methods:
 - 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 4. Obtain Architect's approval of mockups before starting fabrication.
 - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 6. Demolish and remove mockups when directed.

1.7 PRODUCT HANDLING

- A. Deliver and store glass and glazing in manufacturer's protective covering. Handle glass and glazing with care to prevent damage.

1.8 PROJECT/SITE CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F (4.4 deg C).

1.9 GLASS WARRANTY

- A. Warranty for Insulating Units: Warranty sealed insulating glass units for minimum period of ten (10) years, with manufacturer's replacement guarantee, covering as minimum: Defective or failure of seal; material vision obstruction as result of dust collection or film formation between panels or other similar failure and the following specific conditions:
 - 1. Reflective glass whose reflective coating cracks, peels or discolors shall be replaced at no charge (material only) for minimum ten (10) year period beginning on date of Substantial Completion.
 - 2. In addition to replacement of insulated units, provide removal and reinstallation of new units without cost to Owner during first five (5) years of guarantee.
- B. Spandrel Glass Warranty: Spandrel glass whose opacifier delaminates, cracks, peels, wrinkles, discolors, or stains shall be replaced at no charge (material only) for minimum five (5) year period beginning on date of Substantial Completion.
- C. Laminated Glass Warranty: Laminated glass that delaminates shall be replaced at no charge (material only) for minimum 5 years beginning on date of Substantial Completion.
- D. Glazing installer shall coordinate glass and glazing installation with framing systems, and install glass and glazing in accordance with manufacturer's instructions, so that guarantee is maintained.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers for Glass Substrate:
 - 1. AFG Industries.
 - 2. ACH Float Glass Operations (Versalux)
 - 3. Guardian Industries.
 - 4. Pilkington.
 - 5. PPG Industries Glass Group.
- B. Acceptable Fabricators for Insulated Glass Units:
 - 1. Any manufacturer/fabricator with "CBA" classification.
- C. Acceptable Fabricators for Metallic Coated Units:
 - 1. Viracon Incorporated.
 - 2. Tempglass Eastern.
 - 3. PPG Industries Glass Group.
- D. Acceptable Specialty Glass and Unit Manufacturers:
 - 1. Where listed individually with the product description.
 - 2. Vision Glass Units: Unicel Architectural.

2.2 SINGLE GLASS

- A. (GL-1) Clear Float Glass: 1/4 inch thickness; comply with ASTM C1036, Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select).

1. (GL-1T) Clear Tempered Glass: 1/4 inch thickness; comply with ASTM C1036, Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), and further processed to comply with ASTM C1048, Kind FT (fully tempered).
- B. (GL-2) Clear Polished Wire Glass: Category II impact and safety rated by UL meeting local code requirements; 1/4 inch thickness complying with ASTM C1036, Type II pattern and wire glass, flat, Class 1 translucent, Quality q8 glazing, Form 1 wired, polished both sides, Mesh m2 square – 3/4 inch by 3/4 inch diamond pattern - vertical and horizontal.
 1. Product: Safe-Wire Glass with applied film by Aneomstat, or approved substitute.
 2. Wire color as selected by Architect.
- C. (GL-3) Patterned Glass: 1/4 inch thickness with textured face complying with ASTM C1036, Type 1, Class 1, Quality q3.
 1. Pattern: Random p2
 2. Acceptable products:
 - a. Pattern 62; AFG Industries, Inc.
- D. (GL-4) Tinted Glass: 1/4 inch thickness <insert color>; comply with ASTM C1036, Type I (transparent glass, flat), Class 1 (tinted), Quality q3 (glazing select).
 1. Acceptable products:
 - a. Viracon: ??????
- E. (GL-5) Optical Glass: 1/4 inch thickness; comply with ASTM C1036, Type I (transparent glass, flat), Class 1 (tinted), Quality q3 (glazing select).
 1. Acceptable products:
 - a. PPG: Starphire.

2.3 SPECIAL MONOLITHIC GLASS

- A. (GL-10) Lead Glass: Refer to Section 134900 - Radiation Protection.
- B. (GL-11) One-Way Glass: 1/4 inch thickness, transparent mirror, gray;
 1. Acceptable manufacturer:
 - a. Pilkington Mirropane E.P. Transparent Mirror.
- C. (GL-12) Decorative (Art) Glass: 1/4 inch thick nominal, laminated glass with decorative features, consisting of: 2 layers of 1/8 inch glass with 0.037 inch interlayer with seamed edges.
 1. Caesar Color Inc.: ChromaFusion, Architectural Graphic Glass, CF 3461Net
- D. (GL-13) Etched/Sandblasted Glass: Solid glass sheet, sandblasted, with proprietary sealer.
 1. Product: Skyline Design, Solid Sandblast with Skyline Etch Sealer.
 - a. Contact: Mark Toth (773) 278-4660
 2. Size:
 - a. (GL-13A): 3/4 inch
 - b. (GL-13B): 1/4 inch

2.4 LAMINATED MONOLITHIC GLASS

- A. (GL-15) Laminated Clear Glass: 1/4 inch thick laminated glass, 2 layers of 1/8 inch clear glass laminated with 0.030 inch clear PVB inner layer. Edges ground smooth for exposed conditions.
- B. (GL-16) Laminated White Glass: 1/4 inch thick laminated glass, 2 layers of 1/8 inch clear glass laminated with 0.030 inch white PVB inner layer.
- C. (GL-17) Laminated Frosted Glass: 1/4 inch thick laminated glass unit 1/8 inch frosted inner face laminated with 0.030 inch white PVB inner layer, 1/8 inch clear glass.
- D. (GL-18) Laminated Clear Glass: 1/4 inch thick laminated glass, 2 layers of 1/8 inch clear glass laminated with 0.030 inch clear PVB inner layer. Decorative film on back face.

2.5 INSULATING GLASS

- A. (GL-21) Clear Low-E Insulated Glass Unit: One inch thick unit constructed of 1/4 inch clear exterior light, 1/2 inch air space using fabricators warm edge spacer, and 1/4 inch clear interior. High performance low-emissivity coating on No. 2 surface and argon gas in cavities. Glass thickness and thickness of individual glass plies are minimum. One or both plies heat strengthened where required for wind pressure or thermal stress.
1. Visible transmittance: 70 percent.
 2. Shading coefficient: 0.43
 3. Nighttime Winter U-value: 0.29 BTU/hour/square foot maximum.
 4. Acceptable products:
 - a. Viracon: Solarscreen 2000, VE 1-2M.
 - b. Comparable product of other specified manufacturers.
- B. (GL-21T) Clear Tempered, Low-E Insulated Glass Unit: One inch thick unit constructed of 1/4 inch clear tempered exterior light, 1/2 inch air space using fabricators warm edge spacer, and 1/4 inch clear tempered interior light. Low-emissivity coating on No. 2 surface and argon gas in cavity. Glass thickness and thickness of individual glass plies are minimum.
1. Acceptable products:
 - a. Viracon: Solarscreen 2000, VE 1-2M.
 - b. Comparable product of other specified manufacturers.
- C. (GL-22) Tinted Low-E Insulated Glass Unit: 1 inch thick unit constructed of 1/4 inch <insert color> tinted exterior light, 1/2 inch air space using fabricators warm edge spacer, and 1/4 inch clear interior. High performance low-emissivity coating on No. 2 surface and argon gas in cavities. Glass thickness and thickness of individual glass plies are minimum. One or both lights heat strengthened where required for wind pressure or thermal stress
1. Visible transmittance:.
 2. Nighttime winter U-value: BTU/hour/square foot maximum.
 3. Shading coefficient: maximum.
 4. Relative heat gain: BTU/hour/square foot maximum.
 5. Products:
 - a. Viracon
 - b. Comparable product of other specified manufacturers.
- D. (GL-22T) Tinted Tempered, Low-E Insulated Glass Unit: 1 inch thick unit constructed of 1/4 inch <insert color> tinted tempered exterior light, 1/2 inch air space using fabricators warm edge spacer, and 1/4 inch clear interior. High performance low-emissivity coating on No. 2 surface and argon gas in cavities. Glass thickness and thickness of individual glass plies are minimum. .
1. Acceptable products:
 - a. Viracon:
 - b. Comparable product of other specified manufacturers.
- E. (GL-23) Clear Insulated Silkscreen, Low-E Insulated Glass Unit: One inch thick unit constructed of 1/4 inch clear exterior light, 1/2 inch air space using fabricators warm edge spacer, and 1/4 inch clear interior. High performance Low-emissivity coating on No. 2 surface and argon gas in cavity. Silkscreen shading applied to No. 4 surface. One or both plies heat strengthened where required for wind pressure or thermal stress.
1. Visible transmittance: 39 percent.
 2. Outside reflectance: 11 percent maximum.
 3. Nighttime winter U-value: 0.29 BTU/hour/square foot maximum.
 4. Shading coefficient: maximum(glass) and silkscreen percent open: percentage or pattern.
 5. Relative heat gain: BTU/hour/square foot maximum.
 6. Silkscreen Pattern:
 7. Products:
 - a. Viracon:
 - b. Comparable product of other specified manufacturers.

2.6 INSULATED LAMINATED GLASS

- A. (GL-31) Insulated Glass Units: 1-1/16 inch thick laminated, insulated, low-e coated glass unit, 1/4 inch clear heat strengthened outboard light (unless tempered is required for wind pressure or thermal stress), 1/2 inch air space using fabricators warm edge spacer, 2 layers of 1/8 inch clear heat strengthened inboard light laminated with 0.060 inch clear PVB inner layer.
1. Visible transmittance: 39 percent.
 2. Outside reflectance: 11 percent maximum.
 3. Nighttime winter U-value: 0.29 BTU/hour/square foot maximum.
 4. Shading coefficient:
 5. Relative heat gain: BTU/hour/square foot maximum.
 6. Silkscreen Pattern:
 7. Product:
 - a. Viracon: Solarscreen
 - b. Comparable product of other specified manufacturers.
- B. (GL-32) Insulated Glass Units: 1-5/16 inch thick laminated, insulated, low-e coated glass unit, 1/4 inch clear heat strengthened outboard light (unless tempered is required for wind pressure or thermal stress), 1/2 inch air space using fabricators warm edge spacer, 2 layers of 1/4 inch clear heat strengthened inboard light laminated with 0.060 inch clear PVB inner layer.
1. Visible transmittance: 39 percent.
 2. Outside reflectance: 11 percent maximum.
 3. Nighttime winter U-value: 0.29 BTU/hour/square foot maximum.
 4. Shading coefficient:
 5. Relative heat gain: BTU/hour/square foot maximum.
 6. Silkscreen Pattern:
 7. Product:
 - a. Viracon: Solarscreen
 - b. Comparable product of other specified manufacturers.
- C. (GL-33) Insulated Glass Units With Silkscreen Pattern: 1-1/16 inch thick laminated, insulated low-e coated glass unit, 1/4 inch clear heat strengthened outboard light (unless tempered is required for wind pressure or thermal stress), 1/2 inch air space using fabricators warm edge spacer, 2 layers of 1/8 inch clear heat strengthened inboard light laminated with 0.060 inch clear PVB inner layer.
1. Visible transmittance: 39 percent.
 2. Outside reflectance: 11 percent maximum.
 3. Nighttime winter U-value: 0.29 BTU/hour/square foot maximum.
 4. Shading coefficient:
 5. Relative heat gain: BTU/hour/square foot maximum.
 6. Silkscreen Pattern:
 7. Product:
 - a. Viracon: Solarscreen
 - b. Comparable product of other specified manufacturers.

2.7 SPANDREL GLASS

- A. (GL-41) Insulated Glass Units: One inch thick insulated glass unit, 1/4 inch clear heat strengthened outboard light, 1/2 inch air space using fabricators warm edge spacer, 1/4 inch clear heat strengthened inboard light with ceramic coating on the fourth surface.
1. Visible transmittance: 39 percent.
 2. Outside reflectance: 11 percent maximum.
 3. Nighttime winter U-value: 0.29 BTU/hour/square foot maximum.
 4. Shading coefficient??? maximum(glass) and silkscreen percent open: ??? percentage or pattern.
 5. Silkscreen Pattern:
 6. Relative heat gain: BTU/hour/square foot maximum.
 7. Product:
 - a. Viracon: Solarscreen VE 1-2M with ceramic frit.(with silkscreen dot pattern for enhanced shading).

- b. Comparable product of other specified manufacturers.
- B. (GL-42) Glass Units: 1/4 inch thick float glass unit, 1/4 inch clear heat strengthened with ceramic frit on the fourth surface.
 - 1. Acceptable manufacturer and product:
 - a. Viracon: Solarscreen VE 1-2M with ceramic coating (with silkscreen dot pattern for enhanced shading).
- C. (GL-43) Insulated Tinted Glass Units: One inch thick tinted insulated glass unit, 1/4 inch tinted heat strengthened outboard light, 1/2 inch air space using fabricators warm edge spacer, 1/4 inch clear heat strengthened inboard light with ceramic coating on the fourth surface.
 - 1. Visible transmittance:
 - 2. Outside reflectance:
 - 3. Nighttime winter U-value: BTU/hour/square foot maximum.
 - 4. Shading coefficient
 - 5. Silkscreen Pattern:
 - 6. Relative heat gain: BTU/hour/square foot maximum.
 - 7. Product:
 - a. Viracon: Solarscreen VE 1-2M tinted, glass, with ceramic frit.(with silkscreen dot pattern for enhanced shading).

2.8 BULLET-RESISTANT GLAZING

- A. (GL-51) Bullet Resistant Composite Glass Unit: 3/4 inch thick, composite laminated consisting of 1/4 inch thick tempered clear glass, 1/4 inch thick clear polycarbonate light, 1/4 inch tempered clear glass, each layer laminated with 0.60 inch PVB innerlayer, with edges ground smooth.
 - 1. Ballistic Level: UL 752 Level 1.
 - 2. Acceptable products:
 - a. Viracon: GuardVue 100.
- B. (GL-55) Clear Insulated Glass Unit: 1-3/8 inch thick unit constructed of 3/16 inch clear tempered exterior light, 1/2 inch air space using fabricators warm edge spacer, and 7/16 inch clear laminated interior light. Glass thickness and thicknesses of individual glass piles are minimum. One or both lights heat strengthened where required for wind pressure or thermal stress.
 - 1. Ballistic Level: H.P White equivalent to UL 752 Level 1.
 - 2. Acceptable products:
 - a. Viracon: GuardVue 1000.
 - b. Comparable product of other specified manufacturers.
- C. (GL-56) Clear Insulated Glass Unit: 2 inch thick unit constructed of 1/4 inch clear tempered exterior light, 1/2 inch air space using fabricators warm edge spacer, and 1-1/4 inch nominal glass/polycarbonate composite interior light Glass thickness and thicknesses of individual glass piles are minimum.
 - 1. Ballistic Level: UL 752 Level 3
 - 2. Acceptable products:
 - a. Viracon: GuardVue 3000
 - b. Comparable product of other specified manufacturers.

2.9 PLASTIC GLAZING

- A. (PGL-1) Plastic Glazing: 1/4 inch thick clear acrylic panels.
 - 1. Acceptable manufacturer and product:
 - a. Darcy Ferril Studios: Class 2, slumped organic DFS-A1.
- B. (PGL-2) Decorative Plastic Glazing: 3/8 or 1/8 inch thick, as indicated, unit constructed of a high performance resin and fabric encapsulated in resin.
 - 1. Flame Spread: ASTM E84, 0
 - 2. Smoke Development, ASTM D2843, Pass.
 - 3. Burning Characteristics: Class A

4. Manufacturer and product:
 - a. KnollTextiles: Imago

2.10 FIRE-RATED GLAZING

- A. (GL-61) Monolithic Ceramic Glazing: Proprietary product in the form of clear flat sheets of 3/16-inch (5-mm) nominal thickness weighing 2.5 lb/sq. ft. (12.2 kg/sq. m), and as follows:
 1. Fire-Protection Rating: As indicated for the fire window in which the glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Textured on one surface, translucent.
 3. Polished on both surfaces, transparent.
 4. Unpolished on both surfaces, transparent.
 5. Product: Subject to compliance with requirements, provide the following product manufactured by Nippon Electric Glass Co., Ltd. and distributed by Technical Glass Products:
 - a. "Obscure FireLite" (textured).
 - b. "Premium FireLite" (polished on both surfaces).
 - c. "Standard FireLite" (unpolished on both surfaces).
 6. Other Acceptable Manufacturer: Vetrotech Saint-Gobain.
- B. (GL-62) Laminated Ceramic Glazing: Proprietary product in the form of two lites of clear ceramic glazing material laminated together to produce a laminated lite of 5/16-inch (8-mm) nominal thickness; polished on both surfaces; weighing 4 lb/sq. ft. (19.5 kg/sq. m); and as follows:
 1. Fire-Protection Rating: As indicated for the assembly in which the glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Polished on both surfaces, transparent.
 3. Product: Subject to compliance with requirements, provide "FireLite Plus" manufactured by Nippon Electric Glass Co., Ltd. and distributed by Technical Glass Products.
 4. Other Acceptable Manufacturer: Vetrotech Saint-Gobain.
- C. (GL-63) Laminated Glass with Intumescent Interlayers: Proprietary product in the form of multiple lites of Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), Kind FT (fully tempered) float glass laminated with intumescent interlayers; and as follows:
 1. Fire-Protection Rating: As indicated for the assembly in which the glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Product: Subject to compliance with requirements, provide "PyroStop" distributed by Technical Glass Products.
 3. Other Acceptable Manufacturer: Vitrotech Saint-Gobain.
- D. (GL-64) Gel-Filled, Dual-Glazed Units: Proprietary product in the form of two lites of Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), Kind FT (fully tempered) float glass; with a perimeter metal spacer separating lites and dual-edge seal enclosing a cavity completely filled with clear, fully transparent, heat-absorbing gel; and as follows:
 1. Fire-Protection Rating: As indicated for the assembly in which the glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Product: Subject to compliance with requirements, provide "SuperLite II" by SAFTI Div., O'Keeffe's Inc.
- E. (GL-65) Gel-Filled, Triple-Glazed Units: Proprietary product in the form of two outer lites and one inner lite of Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), Kind FT (fully tempered) float glass; each outer lite 6 mm thick; with a perimeter metal spacer separating lites and dual-edge seals, enclosing two cavities each completely filled with clear, fully transparent, water-base, heat-absorbing gel; and a 50.9-mm overall thickness.
 1. Fire-Protection Rating: As indicated for the assembly in which the glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.

2. Product: Subject to compliance with requirements, provide "Pyrovue Commercial" by Advanced Glass Systems Corp.

2.11 SPECIALTY GLASS UNITS

- A. (GL-71): Vision Control, Fire-rated, Tempered Glass Panel with Interior Blinds:
 1. Indoor light: 1/4 inch clear tempered glass (GL-1T)
 2. Outdoor light - at corridor side: 5/16 inch Firelite Plus, 45 minute rated glass (GL-62).
 3. Air Space: 2 inches
 4. Blinds: Built-in manual horizontal blind with [thumbwheel] [removable hand crank][motorized] control from room side.
 - a. Manufacturer:
 - 1) Unicel, Architectural, Montreal, Quebec, Canada, (450) 670-6844 or (800) 668-1580.
 - b. Blind color: As selected by Architect.
 5. Fabricate glass unit with internal blinds and sealed with primary and secondary sealers as recommended by manufacturer. Provide dehydration with dessicant in spacer bars.
 6. Performance Requirements: Canadian Specification CAN2-12.8-M.76 with IGMAC Certification and ASTM E-773-81 "Standard Test Method for Seal Durability of Sealed Insulating Glass Units" and ASTM E-774-81 "Standard Specification for Sealed Insulated Glass Units", level CBA.
 7. Application: Install in hollow metal frame furnished by Division 8 "Hollow Metal Doors and Frames." Hollow metal frame stops must be 1-1/8 high.

2.12 MIRRORS

- A. (GL-91) Unframed Clear Glass Mirrors: Conforming to ASTM C1503, Mirror Select Glazing Quality. 1/4 inch thick (6.0 mm) Type 1, Class 1, Quality q1. Manufacture using copper-free and low-lead mirror coating process. Provide 5 year warranty.
 1. Edge Treatment: Polished mitered edges.
 2. Mounting Accessories: Brushed stainless steel (Type 302) mirror clips similar to KV277 at bottom and KV278 at top where indicated.
 3. Concealed fasteners: Mirror mastic as recommended for applicable for specific substrate and mirror configuration, unless otherwise indicated.
- B. (GL-92) Unframed Mirrors Annealed Laminated Float Glass: 1/4 inch laminated glass mirror ASTM C1503, Type I, transparent flat glass, Quality-Q3; Class 1, clear.

2.13 DECORATIVE FILM

- A. (FLM-1): Refer to Material Identification Codes.

2.14 ACCESSORIES

- A. Framing for Butt Glazing: Aluminum or stainless steel angles as indicated. Anchor to ceiling and floor substrates with appropriate fasteners in locations as indicated.
- B. Setting Blocks: Neoprene, 80 to 90 shore "A" durometer hardness, chemically compatible with glazing sealant or compound, length as recommended by glass manufacturer.
- C. Spacers and Shims: Neoprene, 40 to 50 shore "A" durometer hardness, chemically compatible with glazing sealant or compound, length as recommended by glass manufacturer.
- D. Glazing Tape: Butyl or silicone preshimmed tape similar to Tremco 440 Tape.

2.15 EXTERIOR GLAZING

- A. Glazing gaskets, sealant backers within glazing pockets, and continuous glass spacer pads at structural silicone shall be black heat cured silicone rubber conforming to ASTM C1115-00, Type C. Norton V2100 Thermalbond Tape is acceptable as a glass spacer pad when used in conjunction with structural silicone.
- B. Gaskets for dry glazed system shall be silicone, EPDM, neoprene or Santoprene. Sponge gaskets shall be extruded black neoprene with hardness of 40 +/- 5 durometer Shore A and conforming to ASTM C 509-00. Design sponge gaskets to provide 20% to 35% compression. Dense gaskets shall be black extrusions with Shore A hardness of 75 +/- 5 for hollow profiles and 60 +/- 5 for solid profiles, and conforming to ASTM C1115-00, Type C or to ASTM C 864-99. Injection mold corners of gaskets where compatible with installation procedures.
- C. Structural Glazing System:
 - 1. Sealant: GE Ultraglaze SSG 4000 by General Electric or 795 by Dow Corning. Verify compatibility of sealant with secondary seal of dual seal insulating glass system.
 - 2. Maximum design stress on Structural Silicone Sealant shall not exceed 20 ps

2.16 INTERIOR GLAZING

- A. Type and Manufacturer: Mono one-part acrylic-terpolymer sealant or Proglaze silicone sealant by Tremco, color as selected from manufacturers standard colors.
- B. Other Acceptable Manufacturers: General Electric, DAP, PTI, Pecora.
- C. Fire-Rated Glazing System: As recommended by fire-rated glass manufacturer.
- D. Butt Glazing System: Tremco silicone structural "butt" glazing system, color as selected from manufacturer's standard range.

2.17 SLIDING GLASS DOOR TRACKS

- A. Type and Manufacturer: K & V Esy Roll aluminum track for sliding glass doors by Knappe & Vogt.
- B. Other Acceptable Manufacturers: Stylmark.
- C. Track Assembly: K & V 1092P assembly, including #1093 upper channel, #1097 rollers, #1085 vinyl guides, #1095 shoe, and #1099 lower track.
 - 1. Door Pull: As recommended by door track manufacturer.
- D. Finish: Exposed aluminum extrusions with clear anodized finish.

2.18 FABRICATION

- A. Heat-Treated Float Glass: ASTM C 1048. Fabricate using horizontal roller heating process only. Roll wave distortion parallel to bottom edge of glass as installed. Deviation from flatness at any peak (peak to valley deviation): shall not exceed 0.003 inches in the center of a lite and shall not exceed 0.008 inches within 10.5 inches of the leading or trailing edge.
- B. Insulating Glass Units:
 - 1. Fabricate using both primary and secondary seals and as otherwise required to comply with the IGCC CBA classification.
 - 2. Fabricate using glass from the same manufacturer throughout the Project.
 - 3. Seal Construction: Dual seal design with primary seal of PIB and Silicone Secondary Seal, unless specifically indicated otherwise.
- C. Butt-Glazed Glass: Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

PART 3 EXECUTION

3.1 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. Verify glazing channels are free of burrs, irregularities, and debris.
 - 2. Verify glass is free of edge damage or face imperfections.
 - 3. Inspect door and frames to determine that frames, sash, and stops are set true and straight. Sash rabbets and stops shall be clean and dry at time of glazing.
 - 4. Do not proceed until unsatisfactory conditions have been corrected.
- B. Beginning of installation means acceptance of substrate.

3.2 PREPARATION

- A. Provide glass manufacturer's recommended edge clearances when sizing glass.
- B. Remove protective coatings from surfaces to be glazed.
- C. Clean glass and glazing surfaces to remove dust, oil, and contaminants, and wipe dry.
- D. Verify measurements of sash and openings at Project.
 - 1. Dimensions shown or indicated are given only as a guide for estimating purposes, and actual size shall be determined by measurement of the actual openings. Accurately cut glass to fit openings with proper clearances and setting block height.
- E. Coordinate with and check Shop Drawings furnished by other suppliers of Work affecting this Section to avoid field installation problems.
- F. Before glazing metal sash, remove oil, lacquer, or other material to which the compound will not readily adhere or which will tend to delaminate from metal and cause a leak through the glazing seal.

3.3 INSTALLATION

- A. Comply with glass fabricators recommendations.
- B. Except where curtain wall, window, entrance or glass manufacturer recommends otherwise, comply with Flat Glass Marketing Association (FGMA) Sealant Manual and FGMA Glazing Manual.
- C. Glaze insulated units as recommended by glass and frame manufacturers.
- D. Do not apply glazing materials at temperatures below manufacturer's recommendations or to damp or frosted surfaces. Apply glazing material according to the manufacturer's instructions using proper primers as required.
- E. Set glass using neoprene setting blocks and spacers to insure proper edge clearance and uniform beads of compound. Clearances shall conform to FGMA Glazing Manual requirements. Center glass in glazing rabbets.
 - 1. Butt glazing requirements: Apply mildew resistant silicone sealant to flush depth of joint as indicated by sealant manufacturer.
- F. Check openings to confirm proper clearance at perimeters and between glass and stops.
 - 1. Clean surfaces of rabbet (including stops) and surface of glass which will come into contact with sealant. Use solvents and methods which insure clean, dry surfaces without film or foreign material when sealant is placed.
- G. Remove and replace glazing beads carefully to avoid marking or defacing any portion of frame, sash, or fastenings.

1. Set glass in full bed of glazing tape or sealant. Clean glazing material after stops are installed. Clean excess compound, etc. from glass after setting in conformance with glass manufacturer's recommendations.
 2. If recommended prime surfaces prior to glazing.
- H. Set glass with reams (waves) running horizontally. Set glass with factory attached labels in place.
- I. Setting Blocks: Place setting blocks at locations recommended by glass manufacturer, generally between 1/4 points and 6 inches from corner, except at glazed doors.
1. At glazed doors, provide one block at sill, located 3 inches up from edge of glass at hinge side; one block at hinge side jamb, located 3 inches up from lower edge of glass; one block at head, located 3 inches from edge of glass at latch side of door; and, one block at jamb at lock side of door, located 3 inches down from edge of glass at top corner.
 2. Use blocks of length required to properly support glass. Offset approximately 1 inch from shims.
- J. Glass Installation in Steel (Hollow Metal) Frames:
1. Glaze frames using pre-shimmed tape on both sides. Firmly glaze in place with joints sealed, free of rattles.
 2. Set glass on setting blocks with a full bed of sealant or glazing tape.
- K. Glass Installation in Aluminum Frames:
1. Glaze aluminum frames using preformed EPDM elastomeric glazing extrusion separately or in combination with sealant and pre-shimmed glazing tape in compliance with aluminum frame supplier's recommendations.
 2. Set glass on setting blocks as recommended by manufacturer.
 3. Apply tape and/or sealant to produce uniform sight line even with frame.
 4. Set glass in gaskets with corners sealed.
- L. Glazing Sealant: Along entire bottom edge of light, and up at least 6 inches at each jamb, gun in continuous full bed of sealant to fill voids.
1. Fill entire space, full width of pane, full depth of glass, with sufficient sealant to form heel along inside face and edge of glass.
 2. At other edges (top and sides) gun in continuous heel bead of sealant along edges of glass perimeter to set stop against and into, acting as fill between glass and stop.
 3. Immediately after setting glass, at entire perimeter of glass, gun in sealant between stop and glass so space above spacer is completely filled, without voids.
 4. Place sealant flush with daylight edge of stops, with slight watershed at exterior. Provide straight, smooth surface meeting at opening corners with sharp intersection.
 5. Leave no sealant on exposed surfaces of stops and glass.
- M. Apply structural sealant carefully in uniform thickness pushing bead ahead of nozzle and making sure that entire cavity is filled. Air pockets or voids along edges are not acceptable.
1. Tool joint immediately after application.
 2. Tool neatly, forcing sealant into contact with joint sides, eliminating internal voids and insuring good substrate contact.
 3. Do not tool with soap or detergent solutions.
 4. Install silicone structural butt glazing system in accordance with manufacturer's printed instructions.
- N. Install plastic glazing according to manufacturer instructions.
- O. Install sliding glass door tracks and accessories in accordance with reviewed shop drawings and manufacturer's printed instructions.
- P. Mirror installation: As indicated.
1. Adhere mirrors to substrate with mirror mastic.
- Q. Apply self-adhering decorative film to clean glass surface according to manufacturer instructions.
- R. Installation of Vision control Glass GL-71:

1. Install hollow metal frame into wall prior to installing vision control panel. Installation by Division 8 "Hollow Metal Doors and Frames".
2. Install vision control glass unit on setting blocks and with glazing tape or sealant.

3.4 CLEANING

- A. Remove surplus materials.
- B. Final cleaning of glass by Contractor.

END OF SECTION

SECTION 092200 GYPSUM BOARD SUPPORTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.
3. Shaft wall metal stud partition systems.
4. Runner tracks, furring, bridging, diagonal bracing, lintels, resilient clips, fastenings, and other framing accessories.

B. Related Sections:

1. Section 055000 - Metal Fabrications.
2. Section 092900 - Gypsum Board.

1.2 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:** For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies:** For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

1.3 SUBMITTALS

- A. Shop Drawings:** Submit in accordance with Section 013300, indicating light gauge framing system. Indicate by plan and elevation, stud framing, openings, bracing and blocking, and reinforcement.
- B. Product Data:** Submit required product data and documentation in accordance with Section 013300:
1. Recycled Content of Steel: Submit documentation indicating compliance with specified requirements for percentages by weight of postconsumer and preconsumer recycled content.
- C. LEED Submittals:** Submit required product data and documentation in accordance with Section 018113 - Sustainable Design Requirements and Section 013300 - Submittal Procedures:
1. Product Data for LEED MRc 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.
- D. Evaluation Reports:** ICC-ES reports for metal studs and tracks.

1.4 QUALITY ASSURANCE

- A.** Perform work in accordance with applicable reference standards unless otherwise indicated.
- B.** Provide stud shaft wall system designed and tested by manufacturer to withstand lateral loading (air pressure) of 10 lbs per sq ft for maximum wall height required, and with deflection limited to 1/240 of partition height. (Refer to Section 092900 - Gypsum Board for shaft wall construction).

PART 2 PRODUCTS

2.1 METAL STUD PARTITION AND SOFFIT FRAMING

- A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
 - 1. Steel Sheet Components:
 - a. Comply with ASTM C645 requirements for metal.
 - b. Protective Coating: ASTM A653, G40, hot-dip galvanized zinc coating.
 - c. Refer to Structural Drawings for conditions requiring thicker metal for studs.
 - 2. Recycled Content of Steel Products: Provide products with average recycled content of steel products such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- B. (MET STUD-1) Metal Studs and Runners:
 - 1. Minimum Base Metal Thickness: 33 mils, 0.033 inch minimum.
 - 2. Stud Depth: As indicated.
- C. (MET STUD-2) Shaft Wall Metal Studs: Steel C-H, C-T or I studs hot-dipped galvanized.
 - 1. Minimum Base Metal Thickness: 33 mils, 0.033 inch minimum.
- D. Double-Runners: ASTM C645 top runners, inside runner with 2-inch-deep flanges, and outer runner sized to friction fit inside runner.
- E. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- F. Firestop Track: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - 1. Basis of Design Manufacturers and Products: Subject to compliance with requirements, provide one of the following:
 - a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
 - b. Metal-Lite, Inc.; The System.
- G. Furring and Bracing Members: Provide commercial sheet steel members with protective coating.
 - 1. (MET FURG-1) Hat-Shaped, Rigid Furring Channels: ASTM C645.
 - a. Minimum Base Metal Thickness: 30 mils (0.0312 inch).
 - b. Depth: 7/8 inch.
 - 2. (MET FURG-2) Z-Furring: ASTM C645, with slotted or nonslotted web.
 - a. Minimum Base Metal Thickness: 27 mils (0.0283 inch).
 - b. Depth: As indicated.
 - 3. (MET FURG-3) Cold-Rolled Steel Channels: Channel bridging, carrying channels, steel channel stiffeners and braces:
 - a. Minimum Base Metal Thickness: 54 mils (0.0566 inch).
 - b. Depth: As indicated.
 - 4. (MET FURG-4) Resilient Furring Channels: Asymmetrical steel sheet members, with face attached to single flange by a slotted leg (web), designed to reduce sound transmission.
 - a. Depth: 1/2-inch.
 - 5. (MET FURG-5) Foam furring channel (U shaped) (thermal studs): 33 mils (0.0346 inch) galvanized metal 1/2-inch legs used to reduce thermal transmission.

2.2 ACCESSORIES FOR SUSPENDED CEILINGS AND SOFFITS

- A. Components, General: Comply with ASTM C754 for conditions indicated.
- B. Tie Wire: ASTM A641, Class 1 zinc coating, soft temper, 0.0625 inch diameter wire, or double strand of 0.0475 inch diameter wire.

- C. Hanger Attachment Anchors in Concrete: Fabricated from corrosion-resistant materials with holes or loops for attaching hanger wires and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E488 by a qualified independent testing agency.
 - 1. Cast-in-place anchor, designed for attachment to concrete forms.
 - 2. Postinstalled, chemical anchor.
 - 3. Postinstalled, expansion anchor.
- D. Wire Hangers: ASTM A641, Class 1 zinc coating, soft temper, 0.162 inch diameter.
- E. Rod Hangers: ASTM A510, mild carbon steel.
 - 1. Diameter: 1/4-inch.
 - 2. Protective Coating: ASTM A153, hot-dip galvanized

2.3 MANUFACTURED GRID SUSPENSION SYSTEM

- A. Manufactured Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 1. Products and Manufacturers:
 - a. Drywall Grid Systems by Armstrong World Industries, Inc.;
 - b. Drywall Grid Systems by Chicago Metallic Corporation;
 - c. Drywall Suspension System by USG Corporation.

2.4 FRAMING ACCESSORIES

- A. Fasteners: Galvanized steel, of type and length suitable for adequate penetration of substrate.
- B. Flat Strap and Backing Plate at Interior Stud Walls: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base Metal Thickness: 30 mils (0.0312 inch) .
 - 2. When indicated as Wood Backing and Blocking:
 - a. Refer to Section 061000 for wood requirements.
 - b. Provide fire-resistant treatment.
- C. Asphalt Protection Strips: Strip of 15 lb. asphalt saturated felt at intersection of partitions and masonry walls.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
 - 3. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
 - 4. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.

- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.
- E. Install members to provide surface plane with maximum variation of 1/8 inch in 10 feet in any direction.

3.3 RUNNER TRACK INSTALLATION

- A. Runner Tracks: Continuous track sized to match studs. Align runner tracks accurately to partition layout at both floor and ceiling.
- B. Secure runner tracks to floor and ceiling construction, and to structure above ceilings as recommended by manufacturer with fastener spacing not to exceed 24 inches o.c.
- C. Provide fasteners at corners and ends of runner tracks. Align to configuration required.

3.4 METAL STUD INSTALLATION

- A. Metal Studs: Install metal studs in floor and ceiling runner tracks. Secure studs to runners. Install studs vertically at 16 inches o.c., unless otherwise indicated, and not more than 2 inches from abutting construction, each side of openings, and at corners.
- B. Provide additional studs at exterior corners and 2 inches from inside corners, terminations of partitions, and both sides of control joints. Where partitions abut other construction, provide vertical runner track securely attached to construction. Use full length studs between runner tracks.
- C. Frame door openings with vertical studs attached to each jamb of door frame. Provide additional studs 2 inches from jamb studs. Where head of door frames does not extend to ceiling, frame head of door with horizontal section of runner track attached to jamb studs. Provide vertical studs cut to fit between head and ceiling tracks and attach to tracks. Provide 3/4 inch cold-rolled steel channel stiffener at 6 inches above door head extending at least 2 stud spaces beyond jamb studs, and attach to studs.
 1. Fit runners under and above openings, secure intermediate studs at spacing of wall studs. Brace stud framing system and make rigid.
- D. Partition Heights: Extend partition stud system through suspended ceilings to structural support above, except where indicated to terminate at ceiling. Provide additional bracing for partitions extending above ceiling where indicated.
- E. Coordinate erection of studs with installation of service utilities. Align stud web openings. Coordinate installation of bucks, anchors, blocking, electrical and mechanical work which is to be placed in or behind partition framing. Allow such items to be installed after framing is complete.
- F. Reinforce stud partitions and provide additional metal studs as indicated and required for installation of wall cabinets, wall mounted equipment, wall mounted mechanical and electrical fixtures, accessories, shelves and shelf standards. Provide 54 mils (0.0577 inch) thick steel plate to span minimum of 3 studs for installation of mirrors, toilet accessories or grab bars.
- G. Isolate stud system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned joints to attain lateral support and avoid axial loading.
- H. Splicing Members: Lap furring members 8 inches and runner channels 12 inches and wire-tie near each end of lap. (Stud splicing not permissible.) Lap light gauge studs 12 inches and install screws in both flanges near each end of lap.

- I. Anchor light gauge screw-type partition studs to runner tracks by screwing opposite flanges top and bottom, except screw end studs to both tracks at both flanges.
- J. Erect furring channels horizontally or vertically as indicated. Secure in place on alternate channel flanges at maximum 24 inches on center.
- K. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from plane formed by faces of adjacent framing.

3.5 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install shaft wall framing and accessories in accordance with manufacturer's printed instructions. Anchor components to comply with ratings and performance requirements, and with governing regulations.
- B. Isolate shaft system from transfer of structural loading to system. Both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading.
- C. Install supplementary framing, blocking and bracing to support fixtures, equipment, services, heavy trim, furnishings and similar work which cannot be adequately supported directly on gypsum board shaft system.
- D. Coordinate gypsum board shaft system work with sprayed-on fireproofing of structure, so that both remain complete and undamaged. Patch or replace sprayed-on fireproofing removed or damaged during installation of shaft framing system.

3.6 WALL FURRING INSTALLATION

- A. Erect wall furring directly attached to concrete block and concrete walls.
- B. Erect furring channels horizontally or vertically as indicated. Secure in place on alternate channel flanges at maximum 24 inches on center.
- C. Space furring channels maximum 24 inches on center, not more than 4 inches from floor and ceiling lines or abutting walls.
- D. Erect freestanding metal stud framing by means of adjustable furring brackets in accordance with manufacturer's directions.

3.7 SUSPENSION SYSTEM INSTALLATION

- A. Coordinate location of hangers with other work. Coordinate with Gypsum Association GA-203 for installation of furring members. Do not bridge building expansion joints with support system. Frame both sides of joints with furring and other supports.
- B. Install ceiling framing independent of walls, columns, and above ceiling work.
- C. Install hangers plumb and free from contact with ductwork or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
- D. Space hanger wires 48 inches o.c. along carrying channels and within 6 inches of ends of channel run. Anchor hanger wires to supporting structure. Do not attach hangers to metal deck tabs.
- E. Position channels at proper height and level, and secure with hanger wires. Space main carrying channels at maximum 48 inches on center, not more than 6 inches from perimeter walls. Lap splices minimum 12 inches and secure together 2 inches from each end of splice. Provide clearance between channels and abutting walls or partitions.

- F. Place furring channels perpendicular to carrying channels at 16 inches on center not more than 6 inches from perimeter walls. Lap splices minimum 8 inches and secure together one inch from each end of splice. Provide clearance between furring and abutting walls or partitions. Secure furring to carrying channels with clips.
- G. Reinforce openings in ceiling suspension system which interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum 24 inches past each end of openings.
- H. Laterally brace entire suspension system where required.
- I. Install resilient clips in accordance with manufacturer's printed instructions.
- J. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member transversely between parallel members.

3.8 GRID SUSPENSION SYSTEM INSTALLATION

- A. Grid Suspension Systems: Install in accordance with Manufacturer's instructions.
- B. Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces.
- C. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

END OF SECTION

SECTION 092900 GYPSUM BOARD

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gypsum board panels
2. Board accessories, corner reinforcement, casing beads, control joints.
3. Fasteners, screws and adhesive, wallboard sealant.
4. Gypsum board treatment of joints, corners, metal trim flanges and fasteners.
5. Acoustical insulation, sealant and installation requirements for acoustical gypsum board systems.

B. Related Sections:

1. Section 061000 - Rough Carpentry: Wood framing and blocking.
2. Section 079000 - Joint Protection: Other sealants.
3. Section 081113 - Hollow Metal Doors and Frames.
4. Section 092200 – Gypsum Board Supports: Metal stud framing, suspension system and furring, including resilient clips and shaft wall studs.
5. Section 099000 – Painting.

1.2 DEFINITIONS

- A. Gypsum Board Terminology: Refer to ASTM C11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.3 PERFORMANCE REQUIREMENTS

- A. Acoustic Rated Construction: Meet requirements of GA-600 design manual and referenced acoustic rated system.

1.4 SUBMITTALS

- A. Product Data: Submit Manufacturer's recommended specifications and requirements for gypsum board products and accessories, including control joint placement location at walls and ceilings.

1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory." GA-600, "Fire Resistance Design Manual."
- B. Sound Transmission Characteristics: For gypsum board assemblies with STC ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by a qualified independent testing agency.
1. STC-Rated Assemblies: Indicated by design designations from GA-600, "Fire Resistance Design Manual."

2. Pre-installation Conference: Convene a pre-installation meeting at the beginning of the project to review acoustically rated construction requirements and to coordinate penetrations. Architect, Contractor, Owner's representative and each trade that may need to penetrate acoustically rated construction or will be involved in construction of acoustically rated partitions and related systems must attend. Review layouts and routing for potential penetrating items, discuss reducing or eliminating penetrating items by considering alternate routing, review construction requirements, details and specifications for acoustically rated construction. A follow-up meeting should be scheduled as needed. This meeting can occur in conjunction with a regular construction progress meeting. Publish meeting minutes highlighting topics discussed, actions items and decision made.
- C. Keep copy of GA 216 and Levels of Gypsum Board Finish in field office for duration of project.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver drywall system components and materials in sealed containers and bundles, fully identified with manufacturer's name, brand, type and grade; store in dry, well ventilated space, protected from weather, under cover and off ground.
- B. Stack gypsum panels flat to prevent sagging.

1.7 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with requirements of referenced gypsum board application standards and recommendations of gypsum board manufacturer, for environmental conditions before, during and after application of gypsum board.
- B. Cold Weather Protection: When ambient outdoor temperatures are below 55 degrees F maintain continuous, uniform, comfortable building working temperatures of not less than 55 degrees F for minimum period of 48 hours prior to, during and following application of gypsum board and joint treatment materials or bonding of adhesives.
- C. Ventilation: Ventilate building spaces as required to remove water in excess of that required for drying of joint treatment material immediately after its application. Avoid drafts during dry, hot weather to prevent too rapid drying.
- D. Control Joints: Provide control joints located not over 30 feet on center, regardless if control joints are indicated on drawings or not. Prior to commencing gypsum board work, verify location of control joints with Architect.

PART 2 PRODUCTS

2.1 GYPSUM PANEL PRODUCTS

- A. Gypsum board products not containing asbestos.
- B. Provide gypsum panel materials in accordance with recommendations of GA 216.
- C. Provide gypsum board of types indicated in maximum lengths available to minimize end to end joints in [widths indicated].
- D. (GYP BD) Gypsum Wallboard:
 1. Acceptable Manufacturer's:
 - a. United States Gypsum.
 - b. National Gypsum Company; Gold Bond Building Products.
 - c. Georgia-Pacific.
 - d. CertainTeed Corporation.
 - e. Temple-Inland.
 2. Gypsum Wall Board: ASTM C1396

- a. (GYP BD-1) Fire-rated Board: 5/8 inch thickness.
- b. (GYP BD-2) Fire-rated Mold and Water-resistant Board: 5/8 inch thick, type "X", fire rated gypsum wallboard with water resistant paper face.
 - 1) Provide mold and water-resistant gypsum board as required by local building code and as indicated.
- c. (GYP BD-3) Fire-rated Foil Backed Board: 5/8 inch thick, type "X", fire rated gypsum wallboard.
- d. (GYP BD-11) Fire-rated Board: 1/2 inch thick, type "C", fire rated gypsum wallboard, thickness unless noted otherwise or required by code.
- e. (GYP BD-12) Regular Board: 1/2 inch thick, gypsum wallboard.
- f. (GYP BD-13) Proprietary, Special Fire-Resistive Type: ASTM C1396, having improved fire resistance over standard Type C.
 - 1) Thickness: 1/2 inch.
 - 2) Acceptable Manufacturer:
 - (a) G-P Gypsum Corp.; ToughRock Fireguard C.
 - (b) National Gypsum Company; Gold Bond Fire-Shield C.
 - (c) United States Gypsum Co.; SHEETROCK Brand Gypsum Panels, FIRECODE C Core.
 - (d) CertainTeed Corp.: ProRoc Type C.
- g. (GYP BD-14) Fire-rated Water-resistant Board: 1/2 inch thick, type "C", fire rated gypsum wallboard with water resistant paper face.
- 3. Specialty Gypsum Boards:
 - a. (GYP BD-21) Gypsum Shaft Liner: One inch thick shaft wall liner panel with moisture resistant paper facing. Square edges designed for installation into I, C-H, E, or H metal studs.
 - 1) Acceptable Manufacturer:
 - (a) United States Gypsum Company: Gypsum Liner Panels.
 - (b) National Gypsum Company: Shaftliner.
 - (c) G-P Gypsum Corp.: ToughRock Shaftliner.
 - (d) CertainTeed Corp.: ProRoc Shaftliner with M2Tech Type X.
 - b. (GYP BD-22) Proprietary, Special Fire-Resistive Type: ASTM C1396, having improved fire resistance over standard Type X.:
 - 1) Thickness: 3/4 inch.
 - 2) Acceptable Manufacturer:
 - (a) United States Gypsum Co.; SHEETROCK Brand Gypsum Panels, ULTRACORE.

2.2 INSULATION

- A. Insulation is required to be formaldehyde-free or GreenGuard Indoor Air Quality Certified.
- B. (INSUL-20) Batt or Blanket Insulation: As required to meet requirements of UL Design, Blankets without membrane facing consisting of fibers manufactured from glass; with maximum flame-spread and smoke-developed indices of 25 and 50 per ASTM E 84, respectively; passing ASTM E 136 for combustion characteristics.
 - 1. Thickness: Same as stud depth or as indicated.
 - 2. Width of Batts: Center to center dimension of metal studs and full face to face at other voids.
 - 3. ASTM C665; Type 1 (Unfaced).
- C. (INSUL-24) Unfaced Mineral-Fiber Blanket Insulation: As required to meet requirements of UL Design, Blankets without membrane facing consisting of manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
 - 1. Thickness: Same as stud depth or as indicated.
 - 2. Width of Batts: Center to center dimension of metal studs and full face to face at other voids.
 - 3. ASTM C665; Type 1 (Unfaced).
- D. (INSUL-40) Acoustical Insulation: As required to meet requirements of UL Design, one of following materials: Man made vitreous fiber or resilient glass fibers bonded with thermo-setting resin.
 - 1. Thickness: Same as stud depth or as indicated.

2. Width of Batts: As required to meet UL requirements.
3. ASTM C665, Type 1 (Unfaced).
4. Acceptable Manufacturers and Product:
 - a. Johns Manville: Formaldehyde-Free and Unfaced Sound Control Batts.
 - b. Owens Corning: Fiberglas Sound Attenuation Batts.
 - c. Certainteed: CertaPro AcoustaTherm Batts.
 - d. Thermafiber: Sound Attenuation Fire Blankets (SAFB).

2.3 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Corner Trim, Edge Trim, Inside Corner Trim for Abuse Resistant Gypsum Board:
 1. Provide fully bonded paper faced and joint tape backed copolymer tapered plastic trim at abuse resistant gypsum board.
 2. Provide corner trim as recommended by manufacturer for each condition.
 3. Manufacturer:
 - a. Drywall Systems International No-Coat.
- C. Joint Tape:
 1. Interior Gypsum Wallboard: Paper.
 2. Tile Backing Panels: As recommended by panel manufacturer.
- D. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound, or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat compound to produce Level 5 finish.
- E. Joint Compound for Exterior Applications:
 1. Exterior Gypsum Soffit Board: Use setting-type taping and setting-type, sandable topping compounds.
 2. Glass-Mat Gypsum Sheathing Board: As recommended by manufacturer.
- F. Joint Compound for Tile Backing Panels:
 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by manufacturer.

2.4 ACOUSTICAL SEALANT

- A. Products: Subject to compliance with requirements, provide one of the following:
 1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
 - b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.
 - c. Hilti Incorporated CP 506 Acoustical Sealant
 2. Acoustical Sealant for Concealed Joints:
 - a. Ohio Sealants, Inc.; Pro-Series SC-170 Rubber Base Sound Sealant.
 - b. Pecora Corp.; BA-98.
 - c. Tremco, Inc.; Tremco Acoustical Sealant.
- B. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

- C. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission.

2.5 ACCESSORIES

- A. Fasteners and Anchorages: GA 216, USG Brand screws, type and size as recommended by wallboard manufacturer.
- B. Trim Accessories:
 - 1. Product:
 - a. USG: Dur-A-Bead and Perf-A-Tape corner reinforcement.
 - b. USG #200-A "J" metal trim.
 - c. USG #200-B "L" metal trim.
- C. Control Joints
 - 1. (GYP TRIM-1): Dietrich Zinc Control Joint No. 093
- D. Joint Treatment: USG Perf-A-Tape joint system.
- E. Metal Reveals and Trim: Large scale, extruded aluminum wall and ceiling trim profile as indicated.
 - 1. Manufacturers:
 - a. Gordon Incorporated
 - b. Fry Reglet.
 - 2. (GYP TRIM-3) Profile: As indicated.
 - 3. (WRT-1) Profile: As indicated.
 - a. Refer to Material Identification Codes.
- F. Adhesive: USG Durabond, as recommended by wallboard manufacturer for wood framing.
- G. Laminating Adhesive: Joint compound or adhesive as recommended by wallboard manufacturer for laminating gypsum board face layer to gypsum board base layer.
- H. Joint Sealant: As specified in Section 079000 - Joint Protection.

PART 3 EXECUTION

3.1 GYPSUM BOARD INSTALLATION

- A. Install and finish gypsum board and accessories in accordance with manufacturer's printed instructions and comply with recommendations of GA 216 and ASTM C840, including appendixes. Verify control joint locations at walls and ceilings with Architect.
- B. Use boards of maximum lengths to minimize end butt joints. Where unavoidable, locate end butt joints as far from center of walls or ceilings as possible, and stagger not less than 12 inches in alternate courses of board.
- C. Install gypsum drywall board with face side out. Do not install imperfect, damaged, damp or wet drywall boards. Butt boards together for light contact at edges or ends with not more than 1/16 inch open space between boards. Do not force into place.
- D. Locate edges or end joints over supports except in horizontal applications or where intermediate supports or gypsum board back-blocking is provided behind end joints. Position boards so that both tapered edge joints and mill-cut or field-cut end joints abut. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partition/walls.
 - 1. Form curved surfaces by carefully bending and fastening board to smooth even curve, free of flat or distorted areas and other imperfections. Comply with manufacturer's instructions for dampening of sheets or scoring of back face, if required to form to radius shown.
 - 2. Hold gypsum board 1/4 inch above floor at each type of partition.

- E. Install solid and semisolid drywall partitions made-up of coreboard or gypsum board studs with face courses of exposed gypsum board, laminated with both adhesive and screws.
- F. Isolate gypsum surfaces with control joints or other stress relief where:
 - 1. Partition or furring abuts structural element (except floor) or dissimilar wall or ceiling.
 - 2. Ceiling abuts structural element, dissimilar wall or partition or other vertical penetration.
 - 3. Construction changes within plane of partition or ceiling.
 - 4. Partition or furring run exceeds 30 feet.
 - 5. Ceiling dimensions exceed 30 feet in either direction.
 - 6. Wings of "L", "U" and "T" shaped ceiling areas are joined.
 - 7. Expansion joints occur in exterior wall if expansion joints are not used.
 - 8. Where control joint is near a door opening, locate and align control joint with edge of door frame.
 - a. Ceiling height door frames may be used as control joints.
 - b. Where door frames are less than ceiling height, extend control joints to ceiling from both corners
 - 9. Review location of joints with Architect.
- G. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- H. Provide perimeter isolation where non-load-bearing partitions abut structural decks or ceilings, or vertical structural elements. Allow not less than 1/4 inch, or more than 1/2 inch gap between gypsum and structure. Finish edges of face layer with casing bead. Seal space between casing bead and structure with continuous acoustical sealant bead. Do not attach board directly to tracks.
- I. Cutting, Fitting and Trimming: Accurately measure and precut gypsum drywall units prior to installation. Make cuts from face side by scoring and snapping away from face side or by sawing. Completely cut paper on back face; do not break paper by tearing. Maintain close tolerances for accurate fit at joints between sheets and at framed openings, and allow for covering of edges of cut-outs with plates and escutcheons. Cut edges smooth as required for neat and accurate fit.
- J. Begin fastening from center portion of sheet and work toward edges and ends. Ensure contact of drywall with supports by applying pressure on surface adjacent to fastener being driven. Do not locate fasteners closer than 3/8 inch from edges or ends of sheets. Drive with shank approximately perpendicular to drywall surface.
- K. Drive screws with power screwdriver recommended by drywall manufacturer. Do not hammer drive screws. Set screw heads slightly below surface of drywall, but do not break or strip paper face around screw. Stagger screws on edges and ends of adjacent sheets.
- L. For fire-rated Walls: Fasten to metal framing and furring with screws. Comply with drywall manufacturer's instructions and UL requirements for fastening, but do not exceed 8 inches on center at perimeter and 12 inches on center spacing at the field. Space fasteners not less than 1/4 inch from edges and ends of gypsum drywall.
 - 1. For Non-rated Walls: Fasten perimeter and field at 12 inches on center.
 - 2. For multilayer fire-rated walls: Comply with UL requirements.
 - 3. For Acoustical Walls: Comply with fire-rated wall UL requirements.

- M. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - 1. Z-Furring Members: Apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
- N. Multilayer Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.2 EXTERIOR GYPSUM SHEATHING BOARD INSTALLATION

- A. Exterior Gypsum Sheathing Board: Screw attach with edges butted tightly and ends occurring over firm bearing. Use one inch Type S cadmium plated screws spaced 3/8 inch from ends and edges and approximately 8 inches o.c.
 - 1. Erect exterior gypsum ceiling board perpendicular to supports with staggered end joints over supports.

3.3 ACCESSORIES INSTALLATION

- A. Acoustical Insulation: Install blankets in accordance with manufacturer's printed instructions, with tight joints in blanket units. Use tape, adhesive or staples to hold blankets in place.
 - 1. 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.
- B. Drywall Sealant: Seal perimeter of sound-rated partitions by filling open space between drywall and floor or ceiling construction with continuous bead of sealant. Fill open spaces between drywall and fixtures, cabinets and other flush or penetrating items with continuous bead of sealant. Seal sides and back of electrical boxes to completely close up openings and joints. Seal perimeter of wallboard shaft wall where it abuts other work.
 - 1. Apply joint sealant in accordance with Section 079000 - Joint Protection.
- C. Adhesive Application: Use adhesive recommended by manufacturer for type of substrate indicated. Prepare substrate and laminate wallboard in accordance with manufacturer's printed instructions. Provide temporary fasteners or bracing as recommended until adhesive sets.
- D. Reinforce external corners of drywall with metal corner bead. Securely fasten metal corner beads, edge trim casing beads and control joints.

3.4 FINISHING

- A. Finish exposed drywall surfaces with joints, corners and exposed edges reinforced or trimmed and with joints, fastener heads, trim accessory flanges and surface defects filled with joint compound in accordance with drywall manufacturer's recommendations for smooth, flush surface. Form true, level or plumb lines, without joints, fastener heads, flanges of trim accessories or defects visible after application of field-applied decoration. Exposed metal trim (not filled) will not be acceptable.
- B. Use joint tape to reinforce joints formed by tapered edges or butt ends of drywall units and at interior corners and angles. Set tape in joint compound and apply skim coat over tape in one application. Do not use topping or finishing compounds for setting of tapes.
- C. Apply joint compound to joint. Apply joint compound to fill holes left from removal of screws at intermediate studs. Finish gypsum drywall thereafter, including sanding of final coat, in accordance with ASTM C840.
- D. Where open spaces of more than 1/16 inch width occur between abutting drywall units, except at control joints, prefill joints with joint compound and allow prefill to dry before application of joint tape.

E. Finish Levels of Joints in Interior Gypsum Board Work:

1. Level 0: No taping, finishing, or accessories required.
 - a. Use above suspended ceilings and within other concealed spaces, unless assembly is fire rated, sound rated, sound or smoke controlled, or unless space serves as air plenum.
2. Level 1: At joints and interior angles embed tape in joint compound. Leave surface free of excess joint compound. Tool marks and ridges are acceptable.
3. Level 2: At joints and interior angles embed tape in joint compound with one separate coat of joint compound applied over joints, angles, fastener heads, and accessories.
 - a. Use for mold and water resistant gypsum board indicated for use as a substrate for ceramic tile.
 - b. Use for gypsum board indicated for use as a substrate for wood paneling or acoustical panels.
 - c. Use above suspended ceilings and within other concealed spaces if gypsum board assembly is fire rated, sound rated, sound or smoke controlled, or space serves as air plenum.
4. Level 3: At joints and interior angles embed tape in joint compound with 2 separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges.
 - a. Use where heavy grade wall covering is final decoration.
 - b. Use where gypsum board is base for acoustical ceiling tile.
5. Level 4: At joints and interior angles embed tape in joint compound with 3 separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges.
 - a. Use for all locations, except those indicated for other finish levels.
6. Level 5: At joints and interior angles embed tape in joint compound with 3 separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Apply thin skim coat, as specified in Joint Treatment Materials Article above, to entire surface. Leave surface smooth and free of tool marks and ridges.
 - a. Use where semi-gloss or gloss finish coatings are final decoration.
 - b. Use for 2 story walls with direct natural day lighting (Lobbies, Entries, Rooms with large day lighting and long walls perpendicular to windows).
 - c. Use at ceilings in Lobbies, assembly areas with direct natural day lighting.
 - d. Use where skim coat finish is indicated.

F. Cementitious Backer Units: Finish according to manufacturer's written instructions.

G. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.

3.5 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Architect will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
1. Notify Architect seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
 2. Before notifying Architect, verify installation of mechanical, electrical and other facility services work and Installation of ceiling support framing in areas to receive gypsum board ceilings.

3.6 CLEANING

- A. Recover clean cut-off gypsum construction waste for subsequent processing in preparation for reuse. Coordinate and comply with construction waste recycling plan specified in Section 017420.

END OF SECTION

SECTION 095100 ACOUSTICAL CEILINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical panel ceilings and exposed suspension system.

B. Related Sections:

1. Division 21 – Fire Suppression: Sprinkler heads.
2. Division 23 – Heating, Ventilating and Air Conditioning: Air diffusers.
3. Division 26 – Electrical: Lighting fixtures.
4. Division 27 – Communications: Fixtures.

1.2 DEFINITIONS

- A. AC: Articulation Class.
- B. CAC: Ceiling Attenuation Class.
- C. LR: Light Reflectance coefficient.
- D. NRC: Noise Reduction Coefficient.

1.3 DESCRIPTION

- A. Acoustical Tile Ceilings: Acoustical panel ceilings are described with suspension system for each type of ACT listed in the Material Identification Codes and as described in PART 2.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Requirements:

1. Seismic Restraint: Design system with the following criteria:
 - a. Comply with requirements of building code and local codes.
2. Primary Structure Design Deflection:
 - a. Vertical deflection: <___> inch maximum
 - b. Interstory seismic drift: <___> inch per floor

1.5 REFERENCES

- A. UL - Underwriter's Laboratories Incorporated.
- B. 2006 IBC 803.9.1.1 - Installation of Suspended Acoustical Ceiling Systems.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
1. Ceiling suspension members.
 2. Method of attaching hangers to building structure.
 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

4. Minimum Drawing Scale: 1/8 inch equals 1 foot.
- C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 1. Acoustical Panel: Set of manufacturers standard size samples of each type, color, pattern, and texture.
 2. Exposed Suspension System Members, Moldings, and Trim: Set of 12 inch long samples of each type, finish, and color.

1.7 QUALITY ASSURANCE

- A. Ceilings and Interior Systems Construction Association (CISCA): Acoustical Ceilings, Use and Practice.
- B. Installer's Qualifications: Firm experienced in application or installation of systems similar in complexity to those required for this Project, including specific requirements indicated.
 1. Acceptable to or licensed by manufacturer.
- C. Rated Assemblies: Where acoustical ceilings are components of assemblies indicated for fire-resistance rating, provide acoustical units and suspension systems bearing UL classification marking for applicable UL design number listed in UL "Fire Resistance Index". Where required by applicable UL design, provide protection materials for fixtures and ducts.
 1. Protect mechanical openings in acoustical tile ceilings as per UL outlet protection systems A or B as approved by UL. Provide mineral wool batt insulation and gypsum board where required.
- D. Coordination of Work: Coordinate layout and installation of acoustical ceiling units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components and partition system.
- E. Source Limitations for Ceiling Units and Suspension Systems: Obtain each acoustical ceiling panel and suspension system from one source with resources to provide products of consistent quality in appearance and physical properties without delaying Work.
- F. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:
 1. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E580.
 2. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
 3. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."

1.8 PRODUCT HANDLING

- A. Deliver acoustical ceiling materials in manufacturer's protective packaging. Store and handle materials with care to avoid damage.

1.9 ENVIRONMENTAL CONDITIONS

- A. Do not install acoustical ceiling panels until building is enclosed, sufficient heat is provided, dust generating activities have terminated and all overhead mechanical, electrical and telecommunications work is completed, tested and approved.
 1. Install ceiling tile after carpeting and other interior materials that off-gas has been installed and odors and VOC fumes have dissipated.
- B. Permit wet work to dry prior to commencement of installation.
- C. Maintain uniform temperatures of minimum 60 degrees F and humidity as recommended by acoustical ceiling manufacturer prior to, during and after installation.

1.10 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.

1.11 EXTRA MATERIALS

- A. Provide extra one percent of each type of acoustical ceiling unit to Owner for replacement.
- B. Provide carton (6) hook knives, for concealed suspension system.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Panel and Tile Manufacturers:
 - 1. Armstrong www.armstrong.com
 - 2. USG Interiors. www.usg.com
 - 3. Certaineed www.certaineed.com
- B. Acceptable Suspension System Manufacturers:
 - 1. Chicago Metallic www.chicago-metallic.com
 - 2. Armstrong
 - 3. USG Interior Systems.
 - 4. Certaineed
- C. Metal Acoustical Tile System Manufacturer
 - 1. Hunter Douglas Corporation www.hunterdouglas.com

2.2 SUSPENSION SYSTEM

- A. Exposed Type, ASTM C635: Intermediate duty, double web, cold rolled, hot dipped galvanized steel tees and wall moldings, steel cap with baked on painted polyester finish.
 - 1. Exposed Suspension System: System with main runners and cross tees, exposed surfaces with white enamel finish to match lay-in panels.
 - 2. Products:
 - a. Armstrong Suprafine 9/16 inch grid
 - b. Armstrong Prelude 15/16 inch grid
- B. Exposed Type, ASTM C635: Intermediate duty, double web, cold rolled, aluminum tees and wall moldings, aluminum cap with baked on painted polyester finish.
 - 1. Exposed Suspension System: System with main runners and cross tees, exposed surfaces with white enamel finish to match lay-in panels.
 - 2. Products:
 - a. Armstrong Prelude Plus AL, 15/16 inch grid.
- C. Suspension System Supports:
 - 1. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least three design load, but not less than 12 gauge.
- D. Accessories: Stabilizer bars, furring clips, splices, edge moldings and hold down clips. Provide as required to complete and complement suspended ceiling grid system.
 - 1. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.
 - 2. Edge Moldings and Trim: Metal of types and profiles indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations, including light fixtures, that fit type of edge detail and suspension system indicated.

- a. Provide moldings with exposed flange of the same width as exposed runner.
- 3. Touch-up Paint: Manufacturer's touch-up paint for field cut tegular or other reveal edge tiles.
- E. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in-place.
- F. Carrying Channels and Hangers: Primed steel, size and type to suit application and to rigidly secure complete acoustic unit ceiling system, with maximum deflection of 1/360.

2.3 ACOUSTICAL CEILING SYSTEMS

- A. (ACT-2) Acoustical Lay-in-Panels: Fiberglass panels with vinyl latex paint acoustically transparent membrane and Bioblock surface treatment.
 - 1. Ceiling Tile: Armstrong, Hi-LR Optma Open Plan, No. 3250
 - 2. 24 inch by 48 inch by 5/8 inch thick,
 - 3. Edge Profile: Square tegular.
 - 4. ASTM Classification: Type: XII Form: 2 Pattern: E
 - 5. NRC: ASTM C 423, minimum of 0.95
 - 6. LR: ASTM E 1477: 0.90.
 - 7. Flame spread: 0-25.
 - 8. Exposed Suspension System: 15/16 inch grid system, exposed surfaces with painted cap.
 - a. Armstrong: Prelude XL. 15/16.

2.4 CLEAN ROOM TYPE CEILING SYSTEMS

- A. (ACT-6) Acoustical Lay-in-Panels: Gypsum core panels with vinyl face and back, complying with ASTM E 1264.
 - 1. Ceiling Tile: USG Sheetrock, ClimaPlus, Clean Room
 - 2. 24 inch by 24 inch by 1/2 inch thick
 - 3. Edge Profile: Square.
 - 4. ASTM Classification: Type: XX Pattern: G
 - 5. NRC: N/A
 - 6. LR: ASTM E 1477: 0.77.
 - 7. Flame spread: 0-25.
 - 8. Exposed Suspension System: 1-1/2 inch grid system, exposed surfaces with painted cap.
 - a. USG Donn CE, with factory applied closed cell foam gaskets.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and structural framing to which ceiling system attaches or abuts, with Installer present, for compliance with requirements specified in this and other sections that affect installation and anchorage of ceiling system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half-width units at borders, and comply with reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C636 and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with ductwork 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 and 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, postinstalled mechanical or adhesive anchors, or power-actuated fasteners 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.
 - a. Provide alternate framing method if structural members are spaced too far apart.
 9. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Tolerances: Erect ceiling system level within 1/8 inch in 12'-0" in any direction.
- G. Install fire rated ceiling systems which are components of fire-rated assemblies in accordance with applicable UL "Fire Resistance Index" design numbers.
- H. Form expansion joints as detailed on drawings. Form to accommodate plus or minus one inch movement and maintain visual closure.

3.4 ACOUSTICAL PANEL INSTALLATION

- A. Fit acoustic lay-in panels in place, free from damaged edges or other defects detrimental to appearance and function. Lay directional patterned tile one way with pattern parallel to shortest room axis.
 1. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 2. Field recess units with tegular or reveal edge at border or ceiling edge.

3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
- B. Install lay-in panels level, in uniform plane and free from twist, warp and dents with straight joints, edges in alignment, and edges and corners flush.

3.5 ADJUST AND CLEAN

- A. Adjust sags or twists that develop in ceiling systems and replace part which is damaged or faulty.
- B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage.
 1. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 096500 RESILIENT FLOORING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet vinyl flooring.
2. Resilient flooring accessories.
3. Cleaning and waxing of resilient flooring.

B. Related Sections:

1. Section 033000 - Cast-in-Place Concrete: Finish floor slab and moisture treatment.

1.2 SUBMITTALS

- A. Shop Drawings: Submit layout drawings on vinyl sheet flooring showing seam locations, pattern direction, and type of edge treatment used in accordance with Section 013300.
- B. Slab Moisture Content and Calcium Chloride Test Results: Submit to Architect.
- C. Samples: Submit samples of tile and sheet vinyl flooring in accordance with Section 013300.
- D. Maintenance Instructions: Submit manufacturer's written instructions for recommended maintenance practices for each type of resilient flooring.

1.3 QUALITY ASSURANCE

- A. Provide each type of resilient flooring produced by single manufacturer, single run.
- B. Applicator Qualifications: Installation of resilient flooring shall be by manufacturer's approved applicator.
- C. Conductive Sheet Flooring: Representative of flooring manufacturer shall be at site during sheet flooring installation.
- D. Job Mock-Up: Make sample installation of vinyl base on project surfaces as directed by Architect. Obtain acceptance of sample field installation and accomplish work to equal or exceed standard established by accepted sample.

1.4 PRODUCT HANDLING

- A. Deliver resilient flooring materials in manufacturer's protective packaging. Store and handle flooring with care to prevent damage.

1.5 PROJECT CONDITIONS

- A. Maintain temperature in areas of installation as recommended by resilient flooring manufacturer.

1.6 EXTRA MATERIAL

- A. Replacement Materials: Deliver not less than one percent of total project quantity of each type, size and color of material to Owner for replacement materials.
- B. Clearly identify each container as replacement materials.

PART 2 PRODUCTS

2.1 FLOOR COVERING MATERIALS

- A. Slip Resistance of Flooring Materials: Provide materials with 0.6 coefficient of friction or greater when tested in accordance with ASTM 2047.
- B. Sheet Vinyl Flooring: ASTM F1913, Type as indicated by product selected.
 - 1. (RSF) Type, color and pattern: Refer to Material Identification Codes.
- C. Colors and Patterns: Provide tile units with uniformly distributed color and pattern throughout thickness of tile.

2.2 RESILIENT FLOORING ACCESSORIES

- A. (RB) Vinyl Base: ASTM F1861, Type as indicated by product selected, 4 inch and 5 inch height, 1/8 inch thickness, 120 foot coil lengths. Provide standard top-set cove base, except provide straight base at carpet.
 - 1. Type and color: Refer to Material Identification Codes.
- B. Resilient Transition Edge Strips: Vinyl reducer strips in thickness to match adjacent resilient flooring material. Provide at edges of resilient flooring wherever edge is exposed.
 - 1. (RTS) Color: Refer to Material Identification Codes.
- C. Sheet Cove Cap or Zero Edge Reducing Strip and Fillet Strip: Plastic cap or reducing strip and fillet strip as recommended by manufacturer for integral or flash cove base.

2.3 FILLERS/ADHESIVES/SEALERS

- A. Sub-Floor Filler: White premix latex, mix with water to produce cementitious paste.
- B. Primers and Adhesives: Water-resistant stabilized type as recommended by resilient flooring manufacturer for specific material.
- C. Polish: Type recommended by resilient flooring material manufacturer for material type and location.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which resilient flooring is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 SITE AND SUBSTRATE CONDITIONS

- A. Ensure floor surfaces are smooth and flat with maximum variation of 1/8 inch in 10 feet.
- B. Ensure concrete floors are dry and meet moisture conditions required by flooring and adhesive manufacturer's (3 pounds per 1000 square feet based on ASTM F1869, calcium chloride test) and exhibit negative alkalinity, carbonization or dusting. Also ensure substrate meets requirements of adhesive and flooring manufacturer's requirements. Remove curing agents and other surface residue that may negatively affect adhesion or flooring installation and performance.
- C. Maintain minimum 70 degrees F air temperature at flooring installation area for 3 days prior to, during, and for 24 hours after installation.
- D. Store flooring materials in area of application. Allow 3 days for material to reach equal temperature as area.

3.3 LEVELING

- A. Preparation: Prepare substrate surfaces to receive resilient flooring as recommended by adhesive manufacturer and resilient flooring manufacturer.
 - 1. Remove subfloor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with subfloor filler.
 - 2. Clean floor and apply, trowel and float filler to leave smooth, flat hard surface. Prohibit traffic until filler is cured.

3.4 INSTALLATION - FLOORING

- A. Clean substrate. Spread adhesive evenly in quantity recommended by manufacturer to ensure adhesion over entire area of installation. Spread only enough adhesive to permit installation of flooring before initial set.
- B. Set flooring in place; press with heavy roller to ensure full adhesion. Tightly adhere flooring to substrate without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections.
- C. Lay flooring with joints and seams parallel to building lines to produce minimum number of seams and symmetrical tile pattern as indicated.
- D. Install sheet flooring to minimum of 1/3 full material width and with sheet parallel to length of room unless otherwise indicated. Lay sheet flooring to provide as few seams as possible. Double cut sheet and continuously heat seal or heat weld seams in vinyl sheet flooring to provide seamless installation. Match seam edges for color shading and pattern.
- E. Terminate resilient flooring at centerline of door openings where adjacent floor finish is dissimilar.
- F. Scribe flooring to walls, columns, cabinets, floor outlets and other appurtenances to produce tight joints. Cut flooring neatly to and around fixtures.
- G. Butt flooring tightly to vertical surfaces, thresholds, nosings and edgings. Scribe around obstructions and to produce joints, laid tight, even, and straight. Extend flooring into toe spaces, door reveals, and into closets and similar openings.
- H. Install flooring on covers for telephone and electrical ducts, in pan type floor access covers, and other such items as occur within finished floor areas. Maintain overall continuity of color and pattern with pieces installed in these covers.
- I. Continue flooring through areas to receive moveable type partitions without interrupting floor pattern.
- J. Install feature strips and floor markings where indicated. Fit joints tightly.

3.5 INSTALLATION - ACCESSORIES

- A. Apply wall base to walls, columns, pilasters, cabinetwork and other permanent fixtures in rooms or areas where base is required. Coped inside corners; install preformed outside corners. Tightly bond base to backing and fit joints tight and vertical.
- B. Install base on solid backing. Adhere tightly to wall and floor surfaces throughout length of each piece, with continuous contact at horizontal and vertical surfaces. Scribe and fit to door frames and other obstructions.
- C. Place resilient edge strips tightly butted to flooring and secure with adhesive. Install edge strips at unprotected edges of flooring and at door jambs between rooms with different color or pattern of flooring.
- D. Adhere accessories over each entire surface and fit accurately and securely.

3.6 PROTECTION

- A. Prohibit traffic from floor finish for 48 hours after installation. Protect flooring from damage by use of protective covering.

3.7 CLEAN-UP

- A. Remove excess adhesive or other surface blemishes from floor, base and wall surfaces without damage, and as recommended by flooring manufacturer.

3.8 FINISHING

- A. After completion of project and just prior to final inspection of work, thoroughly clean floors and accessories. Apply sealer, wax and buff, with type of sealer, wax, number of coats and buffing procedures as recommended by flooring manufacturer for new flooring installation. Seal and wax floor and base surfaces in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 096723 RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Preparation of flooring substrate.
 2. Material, application and curing.
 3. Protection to adjacent materials and surfaces.
 4. Clean surfaces and areas of work.

1.2 DESCRIPTION

- A. Resinous Flooring (RES-2): Flooring System comprised of a penetrating two-component epoxy primer, free flowing two-component, 100 percent solids, elastomeric epoxy waterproof membrane, free flowing epoxy formulation consisting of resin, hardener and reactive flow enhancers, brightly colored, quartz silica aggregate broadcast and high performance, two-component clear epoxy sealer.

1.3 SUBMITTALS

- A. Samples: Submit samples in accordance with Section 013300.
- B. Apply minimum 50 sq. ft. of each flooring in locations designated by Architect. Sample floor, when approved, shall be standard of work for this Section. If installation is rejected, remove completely and re-apply new material.

1.4 MAINTENANCE DATA

- A. Upon completion of work of this Section and prior to final acceptance provide Architect 2 copies of manufacturer's instructions covering care and maintenance of flooring.

1.5 QUALITY ASSURANCE

- A. Installer: Firm which has specialized in installing elastomeric liquid flooring required for project, for not less than 3 years, and which is acceptable to manufacturer.
- B. Single Source Responsibility: Obtain primary elastomeric liquid flooring materials including primers, resins, hardening agents, finish or sealing coats from single manufacturer with not less than 3 years of successful experience in supplying principal materials for work of type described in this section. Provide secondary materials only of type and from source recommended by manufacturer of primary materials.

1.6 DELIVERY/STORAGE/HANDLING

- A. Store materials in dry, protected area with minimum temperature of 55 degrees F and away from fires or open flames.

1.7 ENVIRONMENTAL CONDITIONS

- A. Maintain surface and ambient temperature of 60 degrees F for 24 hours before, during and 48 hours after flooring has cured.
- B. Ventilate area in which flooring is being applied. Post and enforce NO SMOKING or OPEN FLAME signs until flooring has cured.

- C. Provide uniform and sufficient lighting in areas of installation.

1.8 PROTECTION

- A. Mask and protect adjacent surfaces and materials from damage. Repair damage to satisfaction of Architect.
- B. Keep traffic out of area in which flooring is being applied or cured.

PART 2 – PRODUCTS

2.1 RESINOUS FLOORING

- A. Type and Manufacturer: 1/8 inch epoxy waterproof flooring with epoxy primer, elastomeric epoxy membrane and slip-resistant wearing surface.
 - 1. Stonshield MRT. by Stonhard, Inc., Maple Shade, NJ, (800)854-0340),
 - 2. Selby Battersby,
 - 3. General Polymer,
- B. Colors: As selected from manufacturer's standard range.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ensure that subfloor is clean, dry, hard, sound, and free of oils or other substance which would affect proper bonding and curing.
- B. Substrate shall be above 50 degrees F, dry and free of excessive water vapor transmission with a relative humidity below 85 percent.

3.2 APPLICATION

- A. Application of resinous flooring shall be performed by trained and experienced applicators franchised by manufacturer under direct full time supervision of manufacturer's plant trained foreman.
- B. Apply flooring in accordance with manufacturer's recommendations for specific project and traffic frequency. Ensure broadcast granules are applied correctly in accordance with manufacturer's printed instructions.
- C. Finish to smooth level surface. Cove base at vertical surfaces.
- D. Cure resinous flooring in accordance with manufacturer's directions, taking care to prevent contamination during application and prior to completion of curing process.

3.3 CLEAN-UP

- A. As work proceeds, clean up excess materials, rubbish and overspray or splash.

END OF SECTION

SECTION 099000 PAINTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Painting and finishing of new materials.
2. Preparation of surfaces for painting and finishing.
3. Repainting and refinishing of existing surfaces as indicated and as specified in Section 017329 - Cutting and Patching.
 - a. Preparation of existing surfaces for repainting and refinishing.
4. Smoke and fire partitions stenciling, and pipe painting.

B. Related Sections:

1. Section 092400 – Portland Cement Plastering: Cement plaster color coat.
2. Section 092900 - Gypsum Board: Spray texture ceiling finish.
3. Section 097200 - Wall Coverings: Primer/sealer on surfaces to receive wall covering.
4. Section 099600 – High Performance Coatings.

1.2 SUBMITTALS

A. Product Data: For each paint system specified. Include block fillers and primers.

1. Material List: Provide 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 manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

B. Samples: Submit paint and transparent finish samples in accordance with Section 013300, for color selection and finish acceptance.

1. Paint Colors, Surface Treatments and Finishes: As selected by Architect. Submit three 4 inch by 6 inch samples to be reviewed for color and sheen. Architect reserves right to select color or finish from any manufacturer, herein specified, as necessary to achieve desired color or finish.

C. Schedule: For acceptance, submit 3 copies of complete schedule showing each product by number and brand name proposed to be used at each surface and location. Generally follow specified outline and list number of coats.

1.3 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide primers and undercoat paint produced by same manufacturer as finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

C. Applicator Qualifications: Engage experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with record of successful in-service performance.

D. Mock-up

1. Job Site Sample Areas: Make sample application of high performance epoxy coating on project surfaces to the extent of one system on one wall of one room as directed by Architect.
 - a. Obtain acceptance of sample field application before making additional applications.
 - b. Accomplish work to equal or exceed standards established by approved samples. Protect and maintain approved field samples through completion of project.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation and instructions for mixing or reducing.
- B. Provide adequate storage facilities. Store paint materials at minimum ambient temperature of 45 degrees F in well ventilated area. Restrict storage to paint materials and related equipment.
- C. Take precautionary measures to prevent fire hazards and spontaneous combustion. Comply with health and fire regulations.

1.5 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with manufacturer's recommendations as to environmental conditions under which painting and finishing can be applied. Do not apply finish in areas where dust is being generated.
- B. Measure moisture content of surfaces using electronic moisture meter. Do not apply finishes unless moisture contents of surfaces are below following maximums:
 1. Plaster and Gypsum Wallboard: 12 percent.
 2. Masonry, Concrete and Concrete Block: 12 percent.
 3. Interior Wood: 15 percent.
- C. Ensure surface temperature and surrounding air temperature is above 40 degrees F before applying finishes. Minimum application temperature for latex paints for interior work shall be 45 degrees F and 50 degrees F for exterior work. Minimum application temperature for transparent finish shall be 65 degrees F, or surface and air temperature shall be 5 degrees above dew point.
- D. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 45 degrees F for 24 hours before, during and 48 hours after application of finishes.
- E. Provide minimum 25 foot candles of lighting on surfaces to be finished.

1.6 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
 1. Quantity: Furnish Owner with extra paint materials in quantities indicated below:
 - a. Interior, Paint: 1 gal. of each color applied.
 - b. Exterior, Paint: 1 gal. of each color applied.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. National Manufacturers:
 1. Sherwin-Williams
 2. Glidden Professional/Devoe Coatings
 3. Benjamin Moore
 4. PPG Industries
- B. Regional Manufacturers:

1. Hirshfields
 2. Diamond Vogel.
- C. Regional Manufacturers:
1. Frazee
 2. Kelly Moore
 3. Vista Paint

2.2 MATERIALS

- A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with 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 that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
 - a. Products specified are by Sherwin-Williams (S-W), unless otherwise indicated, similar quality products of acceptable manufacturers may be furnished.
 - b. Refer to Painting and Finishing Schedule at end of this Section.
 - 1) Colors (PT): Paint Systems indicated in Schedule in Part 3
 - (a) Refer to Schedule of Finishes for manufacturer and color selection.
 - 2) Colors (PTE): Epoxy Paint Systems indicated in Schedule in Part 3
 - (a) Refer to Schedule of Finishes for manufacturer and color selection.
 - 3) Colors (PTS): Polyurethane Paint Systems indicated in Schedule in Part 3
 - (a) Refer to Schedule of Finishes for manufacturer and color selection.
- C. Sheen: When one of following terms is used to denote specific sheen for coating listed, following index shall apply:
1. Flat: Less than 15 units based on 85 degrees of sheen.
 2. Eggshell: 5 to 20 units based on 60 degrees of sheen.
 3. Satin/Low Lustre: 15 to 35 units based on 60 degrees of sheen.
 4. Semi-gloss: 30 to 65 units based on 60 degrees of sheen.
 5. Gloss: Above 65 units based on 60 degrees of sheen.
- D. Paint Types and Colors: Refer to Material Identification Codes.

2.3 MIXING AND TINTING

- A. Deliver paints ready-mixed to job site.
- B. Job mixing and job tinting is not acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive paint and transparent finishes for conditions that would adversely affect execution, permanence or quality of work and which cannot be put into acceptable condition through preparatory work. Do not proceed with surface preparation or coating application until conditions are suitable.

3.2 PREPARATION OF SURFACES

- A. Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as specified, for each particular substrate condition.
 - 1. Remove mildew, by scrubbing with solution of detergent, bleach and warm water. Rinse with clean water and allow surface to dry completely.
 - 2. Remove surface contamination from aluminum surfaces requiring paint finish by steam, high pressure water or solvent washing. Apply etching primer or acid etch. Apply paint immediately if acid etching.
 - 3. Remove contamination from copper surfaces requiring paint finish by steam, high pressure water or solvent washing. Apply vinyl etch primer or acid etch. Apply paint immediately if acid etching.
 - 4. Provide barrier coats over incompatible primers or remove and reprime as required. Notify Architect in writing of anticipated problems in using specified coating systems with substrate primed by others.
- B. Remove hardware, hardware accessories, plates, lighting fixtures, and similar items in-place and not to be finish painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items by workmen skilled in trades involved.
- C. Clean surfaces to be painted before applying paint or surface treatment. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program cleaning and painting so that dust and other contaminants from cleaning process will not fall in wet, newly painted surfaces.
 - 1. Remove dirt, oil, grease and sand if necessary to provide adhesion key, when asphalt, creosote or bituminous surfaces require paint finish. Apply compatible sealer or primer.
 - 2. Remove dirt, grease and oil from canvas and cotton insulated coverings.
- D. Cementitious Materials: Prepare cementitious surfaces of concrete, concrete block and cement plaster to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze. Determine alkalinity and moisture content of surfaces to be painted by performing appropriate tests. If surfaces are found to be sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application of paint.
 - 1. Remove contamination, acid etch and rinse new concrete floors with clear water. Ensure required acid alkali balance is achieved. Allow to thoroughly dry. Repeat procedure if necessary to achieve a medium sandpaper-like profile.
 - 2. Remove dirt, loose mortar, scale, powder and other foreign matter from concrete and concrete block surfaces which are to be painted or to receive clear seal. Remove oil and grease with solution of trisodium phosphate, rinse well and allow to thoroughly dry.
 - 3. Remove stains from concrete and concrete block surfaces caused by weathering of corroding metals with solution of sodium metasilicate after being thoroughly wetted with water. Allow to thoroughly dry.
- E. Gypsum Wallboard: Remove contamination from gypsum wallboard surfaces and prime to show defects, if any. Paint after defects have been remedied.
- F. Plaster Surfaces: Fill hairline cracks, small holes and imperfections on plaster surfaces with patching plaster. Smooth off to match adjacent surfaces. Wash and neutralize high alkali surfaces where they occur.
- G. Galvanized Surfaces: Clean free of oil and surface contaminates with acceptable non-petroleum based solvent.
- H. Ferrous Metals: Clean non-galvanized, ferrous surfaces that have not been shop-coated of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning, complying with Steel Structures Painting Council (SSPC)-SP3.
 - 1. Touch-up shop-applied prime coats which have damaged or bare areas. Wire-brush, solvent-clean, and touch-up with same primer as shop coat.

2. Clean unprimed steel surfaces by washing with solvent. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.
 3. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. (Prime steel including shop primed steels.)
- I. Wood: Clean wood surfaces to be painted of dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off.
1. Prime or seal wood required to be job painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood.
 2. When transparent finish is required, back-prime with one coat of same material as used for surface.
 3. Seal tops, bottoms and cut-outs of wood doors with coat of surface finish immediately upon delivery to job for field painted doors only.
 4. Scrape and clean small, dry, seasoned knots and apply thin coat of white shellac or other recommended knot sealer, before application of priming coat.
 5. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood-filler. Sandpaper smooth when dried.
 6. Remove dust, grit and foreign matter from exterior wood siding which is to receive paint finish. Seal knots, pitch streak and sappy sections. Fill nail holes with exterior caulking compound after prime coat has been applied.
 7. Prior to finishing glue laminated beams, wash down surfaces with solvent and remove grease and dirt.
- J. Existing Surfaces to be Repainted or Refinished: Wash surfaces to remove grease, oil, soil or other matter which will interfere with proper bond of new materials. Scrape and wire brush loose or flaking paint. Fill cracks, voids or other defects.

3.3 MATERIALS PREPARATION

- A. Mix and prepare painting materials and transparent finish materials in accordance with manufacturer's directions.
- B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in clean condition, free of foreign materials and residue.
- C. Stir materials before application to produce mixture of uniform density, and as required during application of materials. Do not stir any film that may form on surface into material. Remove film and, if necessary, strain material before using.

3.4 APPLICATION

- A. 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 type of material applied. Use brush of appropriate size for surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
 4. Apply each coat at proper consistency.
 5. Each coat of paint shall be slightly darker than preceding coat unless otherwise approved by Architect.
 6. Provide finish coats which are compatible with prime paints used.
- B. Do not apply succeeding coats until previous coat has completely dried. Sand between each enamel or varnish coat application with fine sandpaper, or rub surfaces with pumice stone where required to produce even, smooth surface in accordance with coating manufacturer's directions.

1. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.
- C. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive film thickness equivalent to that of flat surfaces.
- D. Finish doors on tops, bottoms, and side edges same as exterior faces, unless otherwise indicated.
- E. Film Thickness: Apply materials in accordance to paint manufacturer's recommendations and spreading rates to provide total dry film thickness as recommended.
 1. Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated
 2. Use precision instruments designed for measuring and evaluation wet and dry films of paints and coatings.
 3. Results measuring less than recommended thickness will require additional material application.
 4. Use of poor hiding colors may require application of additional coats in order to achieve proper coverage and hiding.
- F. Apply first-coat material to surfaces that have been cleaned, pre-treated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
- G. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of undercoat.
- H. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure finish coat with no burn-through or other defects due to insufficient sealing.
- I. Stipple Enamel Finish: Roll and redistribute paint to even and fine texture. Leave no evidence of rolling such as laps, irregularities in texture, skid marks, or other surface imperfections.
- J. Transparent Finish: On exposed portions, use multiple coats to produce glass-smooth surface film continuity of even luster. Provide finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.
- K. Repainting of Existing Surfaces: Where repainting of existing surfaces is required, repaint wall and ceiling surfaces in their entirety, patch or spot painting is not acceptable.
- L. Paint surfaces behind movable equipment or furniture same as similar exposed surfaces. Paint surfaces behind permanently-fixed equipment or furniture with prime coat only.
- M. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.5 MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Refer to mechanical and electrical documents with respect to field painting and finishing requirements. Painting of mechanical and electrical work is not required in pipe chases, tunnels, and mechanical rooms with unpainted walls.
- B. Remove grilles, covers and access panels for mechanical and electrical systems from location and paint separately.
- C. Finish paint primed equipment to color selected.
- D. Prime and paint insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with prefinished coating, or where they are not in finished space or room.

- E. Paint interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers before installation of equipment with 1 coat of flat black paint, to limit of sight line. Paint dampers exposed immediately behind louvers, grilles, convector and baseboard cabinets to match face panels.
- F. Paint exposed piping, insulated piping and conduit occurring in finished areas. Color and texture to match adjacent surfaces.
- G. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

3.6 CLEANING

- A. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered. Touch up and restore damaged or defaced painted areas.
- B. During progress of work keep premises free from unnecessary accumulation of tools, equipment, surplus materials and debris. Remove at end of each workday.
- C. Upon completion of work clean window glass and other paint-spattered surfaces and leave premises neat and clean, to satisfaction of Architect.

3.7 PROTECTION

- A. Adequately cover or otherwise protect finished work of other trades and other surfaces from paint and damage. Repair damage as result of inadequate or unsuitable protection as acceptable to Architect.
 - 1. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.
- B. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.
- C. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items shall be carefully stored, cleaned and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.
- D. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

3.8 PAINTING AND FINISHING SCHEDULE (INTERIOR)

- A. Concrete (Poured or Precast), Portland Cement Plaster (Stucco), Common Brick, Unglazed Tile:
 - 1. Surfaces Included:
 - a. Walls, beams, columns, posts, ceilings.
 - 2. Water Based System: (Premium Quality Acrylic Latex Finish over Acrylic Primer/Sealer)
 - a. Primers:
 - 1) S-W PrepRite Masonry Primer, B28W300.
 - b. Finishes:
 - 1) 2 coats S-W Harmony Interior Latex Flat, B5 Series.
 - 2) 2 coats S-W Harmony Interior Latex Eg-Shel, B9 Series.
 - 3) 2 coats S-W Harmony Interior Latex Semi-Gloss, B10 Series.
 - 3. Solventborne Epoxy System (High Moisture Areas) (PTE-#): (Solventborne Polyamide Epoxy Coating over Polyamide Epoxy Primer)
 - a. Primer:
 - 1) 1 coat S-W Macropoxy 646-100, B58-600 Series.
 - b. Finish:

- 1) 1 coat S-W Macropoxy 646-100, B58-600 Series (non-gloss).
 4. Waterborne Low VOC, Low Odor System: (Low VOC, Low Odor Acrylic Finish over Low VOC, Low Odor Acrylic Primer - not more than 50 grams VOC's per liter, not less than 35 percent solids, ammonia free coating)
 - a. Primer:
 - 1) 1 coat S-W ProGreen 200 Latex Primer, B28W600.
 - b. Finish:
 - 1) 2 coats S-W ProGreen 200 Latex Flat, B30-650.
 - 2) 2 coats S-W ProGreen 200 Latex Eg-Shel, B20-650.
 - 3) 2 coats S-W ProGreen 200 Latex Semi-Gloss, B31-650.
- B. Concrete Floors:
1. Surfaces Included:
 - a. Concrete floors subject to light/moderate traffic.
 2. Solventborne System: (Chemical Resistant Solventborne Polyamide Epoxy Coating)
 - a. Primer:
 - 1) 1 coat S-W Macropoxy 646-100, B58-600 Series.
 - b. Finish:
 - 1) 1 coat S-W Macropoxy 646-100, B58-600 Series with Sharkgrip Slip Resistant Additive.
 3. Solventborne Slip-Resistant System: (Polyamide Epoxy Slip Resistant Epoxy Coating over Bonding Primer)
 - a. Primer:
 - 1) 1 coat S-W Macropoxy 646-100, B58-600 Series.
 - b. Finish:
 - 1) 1 coat S-W Macropoxy 646-100, B58-600 Series with Sharkgrip Slip Resistant Additive.
- C. Unit Masonry Surfaces:
1. Surfaces Included:
 - a. Walls.
 2. Water Based System: (Premium Quality Acrylic Latex Finish over Heavy Duty Acrylic Block Filler)
 - a. Block Filler:
 - 1) 1 coat S-W PrepRite Block Filler, B25W25.
 - b. Finish:
 - 1) 2 coats S-W Harmony Interior Latex Flat, B5 Series.
 - 2) 2 coats S-W Harmony Interior Latex Eg-Shel, B9 Series.
 - 3) 2 coats S-W Harmony Interior Latex Semi-Gloss, B10 Series.
 3. Water Based Epoxy System (High Moisture Areas): (Catalyzed Epoxy Coating over Block Filler)
 - a. Base Coat/Filler:
 - 1) 1 coat S-W Heavy Duty Block Filler B70 Series.
 - b. Finish:
 - 1) 2 coats S-W Macropoxy 646-100, B58-600 Series.
 4. Waterborne Low VOC, Low Odor System: (Low VOC, Low Odor Acrylic Finish over Latex Block Filler, not less than 35 percent solids, ammonia free coating)
 - a. Block Filler:
 - 1) 1 coat S-W Preprite Block Filler, B25W25.
 - b. Finish:
 - 1) 2 coats S-W ProGreen 200 latex Flat, B30-650.
 - 2) 2 coats S-W ProGreen 200 Latex Eg-Shel, B20-650.
 - 3) 2 coats S-W ProGreen 200 Latex Semi-Gloss, B31-650.
- D. Ferrous and Non-Ferrous Metal Surfaces: (Other than ceilings)
1. Surfaces Included:
 - a. Hollow metal doors and frames.
 - b. Steel stairs, ladders and railings.
 - c. Pre-painted surfaces.
 - d. Prime painted hardware.
 - e. Fire extinguisher cabinet trim.
 - f. Radiator, convactor and other heating unit covers.

- g. Uninsulated piping and ductwork.
 - h. Metal access panels.
 - i. Metal louvers and grilles.
 - j. Electric panels (over factory finish).
 - k. Fire horns.
 - l. Metal supports for counters, benches and shelves.
 - m. Exposed and miscellaneous metals.
 - n. Other exposed to view interior ferrous metals not factory finished.
2. Waterborne System: (Waterborne Acrylic Gloss Enamel over Waterborne Metal Primer)
 - a. Primer: (Touch-up if pre-primed)
 - 1) 1 coat S-W Pro-Cryl Universal Primer, B66-310 Series.
 - b. Finish:
 - 1) 2 coats S-W ProClassic Waterborne Acrylic Satin, B20 Series.
 - 2) 2 coats S-W 0 VOC Acrylic Semi-Gloss, B66-650 Series.
 - 3) 2 coats S-W 0 VOC Acrylic Gloss, B66-600 Series.
 3. Waterborne Low VOC, Low Odor System: (Low VOC, Low Odor Acrylic over Waterborne Metal Primer - not more than 50 grams VOC's per liter, not less than 35 percent solids, ammonia free coating)
 - a. Primer:
 - 1) 1 coat S-W DTM Acrylic Primer, B66W1.
 - b. Finish:
 - 1) 2 coats S-W ProGreen 200 Latex Semi-Gloss, B31-600 Series.
 - 2) 2 coats S-W ProGreen 200 Latex Gloss, B31-600 Series.
- E. Gypsum Wallboard and Veneer Plaster Surfaces:
1. Surfaces Included:
 - a. Gypsum wallboard, including over skim coat of joint compound.
 - b. Apply additional coat of primer under deep tone finish paint.
 - c. Veneer plaster.
 - d. Sheens - General: Unless noted otherwise on Room Finish Schedule.
 - 1) Walls: Eggshell
 - 2) Ceilings and Soffits: Flat
 - 3) Walls where indicated on Room Finish Schedule: Semi-gloss.
 2. Water Based System: (Premium Quality Interior Latex Finish over Premium Quality Latex Primer/Sealer)
 - a. Primer:
 - 1) 1 coat S-W Harmony Interior Primer, B11-900 Series.
 - b. Finish:
 - 1) 2 coats S-W Harmony Interior Latex Flat, B5 Series.
 - 2) 2 coats S-W Harmony Interior Latex Eg-Shel, B9 Series.
 - 3) 2 coats S-W Harmony Interior Latex Semi-Gloss, B10 Series.
 3. Waterborne Low VOC, Low Odor System: (Low VOC, Low Odor Acrylic Finish over Low VOC, Low Odor Acrylic Primer - not more than 50 grams VOCs per liter, not less than 35 percent solids, ammonia free coating)
 - a. Primer:
 - 1) 1 coat S-W ProGreen 200 Latex Primer, B28W600.
 - b. Finish: (choose sheen)
 - 1) 2 coats S-W ProGreen 200 Latex Flat, B30-600 Series.
 - 2) 2 coats S-W ProGreen 200 Latex Eg-Shel, B20-600 Series.
 - 3) 2 coats S-W ProGreen 200 Latex Semi-Gloss, B31-600 Series.
 4. Waterborne Epoxy System (High Traffic Areas) (PTE): (Waterborne Polyamide Gloss Epoxy Finish over Acrylic Primer/Sealer)
 - a. Primer:
 - 1) 1 coat S-W Acrylic Primer/Sealer.
 - b. Finish:
 - 1) 2 coats S-W Tile Clad b73w 11643-48769.
 5. Wall Surfaces Under Vinyl Wall Coverings: (Primer/Sealer)
 - a. Primer:
 - 1) 1 coat S-W Pre-Wallcovering Primer, B28W8980.

6. Waterborne Polyurethane System (PTS): (Low VOC, not more than 150 grams VOC's per liter, and complying with LEED Standards)
 - a. Primer:
 - 1) 1 coat S-W Pro-Cryl Universal Primer, B66-310 Series.
 - 2) 1 coat Master Coating Technologies/Scuffmaster "Primemaster" Primer/Sealer.
 - b. Finish:
 - 1) 1 coat Waterbased Acrolon 100, B65-700 Series.
 - 2) 1 coats Master Coating Technologies/Scuffmaster "ScrubTough". For light colors.
 - 3) 2 coats Master Coating Technologies/Scuffmaster "ScrubTough". For dark and bright colors.

F. Plaster Surfaces:

1. Surfaces Included:
 - a. Plaster, apply additional coat of primer under deep tone finish paint.
 - b. Walls, ceilings, soffits.
2. Water Based System: (Premium Quality Acrylic Latex Finish over Aquacrylic Primer/Sealer)
 - a. Primer:
 - 1) 1 coat S-W Harmony Interior Primer, B11-900 Series.
 - b. Finish:
 - 1) 2 coats S-W Harmony Interior Latex Flat, B5 Series.
 - 2) 2 coats S-W Harmony Interior Latex Eg-Shel, B9 Series.
 - 3) 2 coats S-W Harmony Interior Latex Semi-Gloss, B10 Series.
3. Solventborne Epoxy System (High Traffic Areas): (Solventborne Polyamide Gloss Epoxy coating over Acrylic Primer/Sealer)
 - a. Primer:
 - 1) 1 coat S-W Pro-Cryl Universal Primer, B66-310 Series.
 - b. Finish:
 - 1) 1 coat S-W Macropoxy 646-100, B58-600 Series.
4. Waterborne Low VOC, Low Odor System: (Low VOC, Low Odor Acrylic Finish over Low VOC, Low Odor Acrylic Primer - not more than 50 grams VOC's per liter, not less than 35 percent solids, ammonia free coating)
 - a. Primer:
 - 1) 1 coat S-W Progreen Latex Primer, B28W600.
 - b. Finish: (choose sheen)
 - 1) 2 coats S-W Progreen 200 Latex Flat, B30-650.
 - 2) 2 coats S-W Progreen 200 Latex Eg-Shel, B20-650.
 - 3) 2 coats S-W ProGreen 200 Latex Semi-Gloss, B31-650.
5. Waterborne Polyurethane System (PTS): (Low VOC, not more than 150 grams VOC's per liter, and complying with LEED Standards)
 - a. Primer:
 - 1) 1 coat S-W Pro-Cryl Universal Primer, B66-310 Series.
 - 2) 1 coat Master Coating Technologies/Scuffmaster "Primemaster" Primer/Sealer.
 - b. Finish:
 - 1) 1 coat Waterbased Acrolon 100, B65-700 Series.
 - 2) 1 coats Master Coating Technologies/Scuffmaster "ScrubTough". For light colors.
 - 3) 2 coats Master Coating Technologies/Scuffmaster "ScrubTough". For dark and bright colors.

G. Wood Surfaces Painted: (Other than Floors)

1. Surfaces Included:
 - a. Hardwood rails and benches, except where pre-finish is indicated.
 - b. Millwork, except where pre-finish is indicated.
 - c. Wood doors and frames, except where pre-finish is indicated.
 - d. Plywood shelving.
 - e. Other wood for paint finish.
 - f. Concealed surfaces of wood items to be back-primed.
2. Water Based System: (Premium Quality Acrylic Latex Finish over Acrylic Latex Wood Undercoater)
 - a. Primer:

- 1) 1 coat S-W Preprite Classic Primer, B28W101.
 - b. Finish:
 - 1) 2 coats S-W VOC Acrylic Semi-Gloss, B66-650 Series.
 - 2) 2 coats S-W 0 VOC Acrylic Gloss, B66-600 Series.
 - 3. Fire Retardant (Intumescent) System: (Chlorinated-Vinyl Acetate Intumescent Finish System) (NONE MEETING CURRENT LEED REQUIREMENTS)
 - a. Primer:
 - 1) 1 coat ICI/ Prep & Prime Alkyd Wood Primer Sealer #1120.
 - b. Finish:
 - 1) 2 coats ICI/Ultra-Hide Insul-Blaze Fire Retardant Gloss Finish #5029.
 - 2) 2 coats ICI/Ultra-Hide Insul-Blaze Fire Retardant Flat Finish #5030.
 - 3) 2 coats ICI/Ultra-Hide Insul-Blaze fire Retardant Semi-Gloss Finish #5031.
 - 4. Waterborne Low-VOC, Low Odor System: (Low-VOC, Low Odor Acrylic Finish over Acrylic Latex Wood Primer - not more than 50 grams VOC's per liter, not less than 35 percent solids, ammonia free coating)
 - a. Primer:
 - 1) 1 coat S-W Premium Wood Primer, B28W8111.
 - b. Finish:
 - 1) 2 coats S-W ProGreen Latex Eg-Shel, B20-600 Series.
- H. Painted: (Floors Wood Surfaces)
- 1. Surfaces Included:
 - a. Wood floors and decks, pedestrian traffic only.
 - 2. Water Based System: (Acrylic Low Sheen Enamel over Acrylic Low Sheen Enamel)
 - a. Primer:
 - 1) 1 coat S-W ArmorSeal Tread Plex, B90W111.
 - b. Finish:
 - 1) 1 coat S-W ArmorSeal Tread Plex, B90W111.
- I. Wood Surfaces Transparent Finish (Stained and Varnished): (Other than Floors)
- 1. Surfaces Included:
 - a. Hardwood handrails and guardrails, except where paint or prefinish is indicated.
 - b. Wood doors and frames, except where paint or prefinish is indicated.
 - c. Laminated wood benches.
 - d. Drawer sides and drawer surfaces concealed in closing position.
 - e. Cabinet interiors.
 - f. Concealed surfaces of wood items to be back-primed with varnish.
 - g. Plywood shelving.
 - h. Other wood for stain and varnish (transparent) finish.
 - 2. Waterborne System: (Waterborne Acrylic Finishes over Alkyd Penetrating Stain)
 - a. Transparent Stain:
 - 1) 1 coat S-W Minwax 250 Interior Stains.
 - 2)
 - b. Finish:
 - 1) 2 coats S-W Woodclassics Waterborne Varnish, A68 Series.
- J. Wood Surfaces Stained and Varnished: (Floors)
- 1. Surfaces Included:
 - a. Wood floors and decks, pedestrian traffic only.
 - 2. Polyurethane Varnish over Penetrating Stain)
 - a. Transparent Stain:
 - 1) 1 coat S-W Minwax 250 Interior Stains.
 - b. Sealer:
 - 1) 1 coat ICI/Woodpride Polyurethane Gloss Finish #1908, reduced 8:1 with mineral spirits.
 - c. Finish:
 - 1) 2 coats ICI/Woodpride Gloss Polyurethane Varnish #1908.
 - 2) 2 coats ICI/Woodpride Satin Polyurethane Varnish #1902.

3.9 SPECIAL SURFACES

- A. Ferrous and Non-Ferrous Metal Surfaces: (Ceilings)
 - 1. Surfaces Included:
 - a. Bar joist, decking and supports.
 - b. Galvanized ductwork
 - c. Exposed metal at ceiling.
 - 2. Waterborne Systems: (Waterborne Dryfall over Waterborne Metal Primer)
 - Primer: (touch-up if pre-primed)
 - 1) 1 coat 1 coat S-W Pro-Cryl Universal Primer, B66-310 Series.
 - b. Finish:
 - 1) 1 coat S-W Waterborne Acrylic Dry Fall, B42W2.
- B. Spray Applied Dry Fall Painted Materials (Non-Metallic):
 - 1. Surfaces Included:
 - a. Spray fireproofing (SFRM)
 - b. Acoustical tile ceilings.
 - c. Acoustical plaster ceilings.
 - 2. Waterborne System: (Waterborne Dryfall over Waterborne Metal Primer)
 - a. Primer: (touch up if pre-primed)
 - 1) 1 coat S-W Pro-Cryl Universal Primer, B66-310 Series.
 - b. Finish:
 - 1) 1 coat S-W Waterborne Acrylic Dry Fall, B42W2.
 - 3. Modified Epoxy Systems: (Modified Epoxy Dryfall over Corrosion Resistant Epoxy Metal Primer)
 - a. Primer: (Touch up if Preprimed)
 - 1) 1 coat S-W Pro-Cryl Universal Primer, B66-310 Series.
 - b. Finish: 1 coat S-W Waterborne Acrylic Dry Fall, B42W2 (not an epoxy).
- C. Fire-retardant finish coating to provide required fire-rating, Class A (B, C):
 - 1. Surfaces Included:
 - a. Wood ceiling.
 - b. Wood paneling.
 - c. Wood trim.
 - d. Other wood for fire-retardant finish.
 - 2. Intumescent System: (Synthetic Resin finish over Clear Shellac) (NONE MEETING CURRENT LEED REQUIREMENTS)
 - a. Sealer:
 - 1) 1 coat all purpose 3 lb. cut Clear Shellac.
 - b. Intermediate:
 - 1) 1 coat Flame Control Fire Retardant Varnish #166.
 - c. Finish:
 - 1) 1 coat Flame Control Fire Retardant Satin Varnish Overcoat #167.
- D. Insulated items in rooms with painted walls:
 - 1. Surfaces Included:
 - a. Piping, ducts, tanks, and equipment.
 - 2. Waterborne System: (Premium Quality Acrylic Latex finish over -Acrylic Primer)
 - a. Primer:
 - 1) 1 coat S-W Moisture Vapor Barrier Primer, B72W1.
 - b. Finish:
 - 1) 2 coats S-W ProMar 200 Latex Eg-Shel, B20W2200 Series.
- E. Black Enamel Finish:
 - 1. Surfaces Included:
 - a. Duct throats for visible distance but not less than approximately 24 inches behind supply or return air grilles, registers, louvers.
 - b. Wood blocking exposed at reveals.
 - 2. Water Based Systems (Low-VOC): (Acrylic Latex Finish)
 - a. Finish:

- 1) 1 coat S-W ProMar 400 Latex Flat Black, B30W400 Series.

3.10 REPAINTING OF EXISTING SURFACES

A. Existing Surfaces:

1. Surfaces Included:
 - a. Existing surfaces where indicated to be repainted.
 - b. Existing metal lockers (casework) (metal toilet compartments) where indicated to be repainted.
2. Alkyd/Latex System:
 - a. Primer/Finish:
 - 1) 2 coats paint similar to type listed above.
3. Electrostatic System:
 - a. Primer/Finish:
 - 1) 2 coats electrostatic paint finish.

3.11 SMOKE AND FIRE PARTITIONS

- A. Stenciling: Smoke and Fire partitions shall be stenciled with the appropriate Hour-rating/Minute rating, i.e., "SMOKE and/or FIRE (1 HR /2 HR)," etc., above ceilings on both sides of walls in letters not less than 2-1/2 inches high.
 1. Stenciling shall be located above every door and no more than ten feet on center.
 2. Stencil every change in direction of rated walls.
 3. Indicate the end of a rated wall with a 2-inch vertical red line with an arrow pointing to the direction of the rated wall.

- B. Lead Walls: Stencil above the ceiling, both sides of walls lined with lead with the height of the lead and the density, i.e., "7 FOOT A.F.F./4 LB. LEAD".

- C. Latex System:
 1. Primer/Finish:
 - a. Provide red semi-gloss paint.

3.12 PIPE PAINTING

A. Painting Colors:

1. Surfaces Included: All exposed surfaces. Colors to match Sherwin Williams
 - a. High and Low Pressure Steam: Safety Yellow
 - b. High and Low Pressure Condensate Return Line and Tank: Brass
 - c. High and Low Pressure Boiler Feed Water: Mill Ivory
 - d. High and Low Pressure Exhaust Breaching: Silver
 - e. Vacuum: Pure White
 - f. Oxygen: Rain Forest
 - g. Medical Air: Modelar Tan
 - h. Lab Air: Pallet Tan
 - i. Nitrous Oxide: Blue Print
 - j. 20 lb. Air for Pneumatic controlled Equipment and 80 lb., Air for Pneumatic Controlled Equipment, and Compressed Air: Turbine Blue.
 - k. Nitrogen: Graphite
 - l. Gas: Safety Orange
 - m. Oil: Black
 - n. Domestic Water: Circuit Breaker
 - o. 120 Degree Hot Soft Water: Polymer Blue
 - p. Soft water and Polished Soft Water: Hydro Blue
 - q. Non Potable Water: Toggle Teal
 - r. Chilled Water Closed Loop & Pumps: Safety Blue.
 - s. Condenser Water & Pumps: Dewpoint
 - t. Radiation Closed Loop & Pump: Solar Yellow
 - u. Reheat Closed Loop & Pump: Junction Yellow
 - v. Fire Sprinkler Lines: Safety Red
 - w. A.C. Freon Lines: Plumb
 - x. Electrical Conduits: Structural Grey.

END OF SECTION

SECTION 101100 VISUAL DISPLAY BOARDS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Markerboards

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Include computer system requirements for electronic markerboards.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show location of panel joints.
 - 2. Show location of special-purpose graphics for visual display surfaces.
 - 3. Include sections of typical trim members.
 - 4. Include wiring diagrams for motor-operated, sliding visual display units.
- C. Samples for Initial Selection: For each type of visual display surface indicated and as follows:
 - 1. Actual sections of [~~porcelain-enamel face sheet~~] [~~painted-finish chalkboard~~] [~~melamine visual display surface~~] [~~tack assembly~~] [~~visual display wall panel~~] [~~display rail~~] [~~visual display fabric~~].
 - 2. Samples of accessories involving color selection.
- D. Samples for Verification: For each type of visual display surface indicated and as follows:
 - 1. Visual Display Surface: Not less than **8-1/2 by 11 inches**, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
 - 2. Trim: **6-inch**- long sections of each trim profile.
 - 3. [**Rail**] [**Modular**] Support System: **6-inch**- long sections.
 - 4. Accessories: Full-size Sample of each type of accessory.
- E. Maintenance Data: For visual display surfaces to include in maintenance manuals.
- F. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative of motor-operated, sliding visual display unit manufacturer for installation and maintenance of units required for this Project.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of visual display surfaces and are based on the specific system indicated. Refer to Section 016210 - Product Options and Substitution 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. Fire-Test-Response Characteristics: Provide fabrics with the surface-burning characteristics indicated, as determined by testing identical products per ASTM E84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
- 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.

1.4 PRODUCT HANDLING

- A. Deliver factory-built visual display boards, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.
- B. Store visual display units vertically with packing materials between each unit.

1.5 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 become slick or shiny.
 - c. Surfaces exhibit crazing, cracking, or flaking.
 - 2. Warranty Period: 50 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MARKERBOARDS

- A. (MKBD-1) Description: 24 gauge Porcelain Enamel Steel Skin mounted on 7/16 inch MDF core with moisture barrier backing.
 - 1. Core: Medium density fiberboard
 - 2. Moisture Backing: 0.005 inch aluminum foil
 - 3. Finish panel: Low gloss.
 - 4. Color: White
 - 5. Size: 4 foot high unless noted otherwise, length as indicated.
 - 6. Trim: 1-1/4 inch exposed aluminum face, satin anodized finish
 - 7. Option: Marker tray, full length
 - 8. Attachment: Angle clips at 24 inches on center.
 - 9. Product: Claridge, Type A, Series 3 by Claridge Products.
 - a. Other Acceptable Manufacturers:
 - 1) ADP Lemco Incorporated.

2.2 MARKERBOARD WALL COVERING

- A. (MKBD-3): WallTalkers, Magrite II, magnetic, moderate gloss vinyl surface for dry erase markers. M248-05: 48-inch width, 39.4 ounces per square yard, woven backing.
 - 1. Manufacturer: RJF International Corporation, Fairlawn, Ohio: WallTalkers, Magrite II
 - 2. Color: White.
 - 3. Installation: Adhere to wall surface with manufacturer recommended adhesive. Railroad product to achieve seamless installation.

2.3 FABRICATION

- A. Factory pressure laminate board surfaces to 1/2 inch gypsum board, or 1/2 inch particle board, 0.015 aluminum balance sheet.
- B. Chalkboards and markerboards shall be fully backed with aluminum foil.
- C. Factory assemble visual display boards in accordance with reviewed shop drawings.

- D. Make joints only where total length exceeds maximum manufactured length (16 feet by 4 feet or 12 feet by 5 feet). Fabricate with minimum number of joints, balanced around center of board.
- E. Provide mullion trim at joints between chalkboard, markerboard and tackboard. Provide vertical spline joint system between abutting sections of chalkboard and markerboard.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which visual display boards are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install visual display boards in accordance with reviewed shop drawings and manufacturer's printed instructions. Keep perimeter lines straight, plumb and level.
- B. Provide grounds, clips, backing, brackets, anchors, trim and accessories. Use splines at joints to maintain surface alignment and smooth joints.
- C. Set visual display boards plumb and level, and securely attach to adjacent construction. Join parts with neat, precision fit.
- D. Clean units in accordance with manufacturer's instructions.

END OF SECTION

SECTION 102600 WALL AND DOOR PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall and corner guards, and accessories.

1.2 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013300.
- B. Samples: Submit samples for color selection and appearance acceptance.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Deliver wall and corner guards in manufacturer's protective covering. Handle finished surfaces with care to prevent damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers for Vinyl/Alloy Products:

1. C/S Group: Acrovyn.
2. Comparable products of the following manufacturers are acceptable:
 - a. Tepromark International Inc.: PVC.
 - b. InPro Corporation .
 - c. Pawling Corporation, Standard Products Division: Pro-Tek.
 - d. Korogard Wall Protection Systems:
 - 1) Decorative Surfaces, Grand Rapids, MI; 800-515-2111.
 - 2) Koroseal Midwest; Chicago Office, 9201 W. Belmont Ave, Franklin Park, IL, 60131; 866-259-1328; Contact Bruce F. Hansen, 414-704-5180.
 - 3) ComWall, a Division of IPM Group, Inc., Des Moines, IA, 800-659-4455.
 - 4) Koroseal Wallcoverings West, a Division of RJF International Corporation, Burbank, CA, 800-935-9359.
3. Drawings and specifications are based on manufacturer's proprietary literature from Construction Specialties, unless otherwise indicated. Other manufacturers shall comply with minimum levels of material and detailing indicated.

B. Acceptable Manufacturers for Stainless Steel:

1. Wilkinson Company.
2. Comparable products of the following manufacturers are acceptable:
 - a. MM Systems Corp.
 - b. K.J.Miller Corp.
3. Drawings and specifications are based on manufacturer's proprietary literature from Wilkinson Company, unless otherwise indicated. Other manufacturers shall comply with minimum levels of material and detailing indicated.

2.2 STAINLESS STEEL CORNER GUARDS

A. Corner Guards:

1. (WCG-4): Surface mounted for 90 degree angle corner; 16 gauge stainless steel with No. 4 satin finish having 1/8 inch radius corner.
2. Size: 3-1/2 inch by 3-1/2 inch legs.

3. Height: 4 feet up from top of base, unless otherwise indicated.
 4. Attachment material: Adhesive appropriate for wall material
- B. Manufacturer and Type:
1. Model WCG - 1/8C cement-on-type corner guards by Wilkinson Chutes.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions in which wall surface protection components and wall protection systems will be installed.
 1. Complete finishing operations, including painting, before beginning installation of wall surface protection system materials.
- B. Wall surfaces to receive impact-resistant wall covering materials shall be dry and free from dirt, grease, loose paint and scale.
- C. Do not proceed with installations until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prior to installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Install wall and corner guards and accessories in accordance with reviewed shop drawings and manufacturer's printed instructions.
- B. Install true, plumb and level, securely and rigidly anchored to substrate.
- C. Install wall protection according to manufacturer instructions.

3.4 CLEANING

- A. Immediately upon completion of installation, clean plastic covers and accessories using standard ammonia based household cleaning agent. Clean metal components in accordance with manufacturer's recommendations.
- B. Remove excess adhesive using methods and materials recommended by manufacturer.
- C. Remove surplus materials, rubbish and debris resulting from installation upon completion of work and leave areas of installation in neat, clean condition.

END OF SECTION

SECTION 102813 TOILET ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Toilet and bath accessories.

B. Related Sections:

1. Section 088000 - Glazing: Glass mirrors.
2. Section 092900 - Gypsum Board: Metal anchor reinforcement in walls.
3. Section 093000 - Tiling: Ceramic tile bath and shower accessories.

1.2 SUBMITTALS

A. Submit in accordance with Section 013300

B. Product Data: Illustrate each accessory at large scale and show installation method.

C. Samples: Submit finish samples.

D. Schedule indicating types, quantities, sizes, and installation locations (by room) for each toilet accessory item to be provided for project.

E. Setting drawings where cutouts are required in other work, including templates, substrate preparation instructions, and directions for preparing cutouts and installing anchorage devices.

F. Maintenance instructions, including replaceable parts and service recommendations.

1.3 QUALITY ASSURANCE

A. Product Options: Accessory requirements, including those for materials, finishes, dimensions, capacities, and performance, are established by specific products indicated in the Toilet and Bath Accessory Schedule.

1. Products of other manufacturers listed in Part 2 with equal characteristics, as judged solely by Architect, may be provided.
2. Do not modify aesthetic effects, as judged solely by Architect, except with Architect's approval. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.4 DELIVERY, STORAGE AND HANDLING

A. Do not deliver accessories to site until rooms in which they are to be installed are ready to receive them.

B. Pack accessories individually in manner to protect accessory and its finish.

1.5 PROTECTION

A. Protect adjacent or adjoining finished surfaces and work from damage during installation of work of this section.

1.6 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.

1.7 WARRANTY

- A. General Warranty: Special warranty 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. Manufacturer's Mirror Warranty: Written warranty, executed by mirror manufacturer agreeing to replace mirrors that develop visible silver spoilage defects within minimum warranty period indicated.
 - 1. Minimum Warranty Period: 15 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide accessories by one of the following:
- B. Washroom Equipment
 - 1. Bobrick Washroom Equipment Inc.
 - 2. American Specialties Inc.
 - 3. Bradley Corporation
 - 4. GAMCO
- C. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, those indicated in the Toilet and Bath Accessory Schedule at the end of Part 3.

2.2 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch minimum nominal thickness, unless otherwise indicated. Adhesive: Epoxy type contact cement.
- B. Sheet Steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.0359-inch minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.
- C. Galvanized Steel Sheet: ASTM A 653/A 653M, G60.
- D. Mirror Glass: ASTM C 1036, Type I, Class 1, Quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411.
- E. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication
- F. Fasteners, Screws, and Bolts: Hot dip galvanized. Expansion Shields: Fiber, lead or rubber as recommended by accessory manufacturer for component and substrate. Provide exposed fasteners with finish to match accessories.

2.3 FINISHES

- A. Shop Primed Ferrous Metals: Pretreat and clean, spray apply one coat primer and bake.
- B. Chrome/Nickel Plating: Satin finish.
- C. Stainless Steel: No. 4 satin finish.

- D. Baked-Enamel Finish: Factory-applied, gloss-white, baked-acrylic-enamel coating.

2.4 FABRICATION

- A. General: Names or labels are not permitted on exposed faces of accessories. On interior surface not exposed to view or on back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.
- B. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.
- C. Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.
- D. Framed Glass-Mirror Units: Fabricate frames for glass-mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper-resistant glass installation and prevents moisture accumulation.
- E. Provide galvanized steel backing sheet, not less than 0.034 inch and full mirror size, with non-absorptive filler material. Corrugated cardboard is not an acceptable filler material.
- F. Mirror-Unit Hangers: Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:
 - 1. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - 2. Heavy-duty wall brackets of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
- G. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 EXECUTION

3.1 PREPARATION

- A. Deliver inserts and rough-in frames to jobsite at appropriate time for building-in. Provide templates and rough-in measurements as required.
- B. Before starting work notify Architect in writing of conflicts detrimental to installation or operation of units.
- C. Verify exact location of accessories with Architect. Verify blocking is in place prior to gypsum board installation.
- D. Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units.

3.2 INSTALLATION

- A. Install fixtures, accessories and items in accordance with manufacturer's printed instructions.
- B. Install true, plumb and level, securely and rigidly anchored to substrate and sealed to protect structural elements of wall from moisture.
- C. Use tamper proof (security) type fasteners.

3.3 ADJUSTING AND CLEANING

- A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.
- B. Clean and polish exposed surfaces in accordance with manufacturer's recommendations after removing labels and protective coatings.

3.4 TOILET AND BATH ACCESSORY SCHEDULE

A. Coat Hooks:

- 1. (CH-1) Robe Hooks: Bobrick 76717, satin finish, 1-5/8 inch projection, single hook.
- 2. (CH-2) Robe Hooks: Bobrick 76727, satin finish, 1-7/8 inch projection, double hook.

B. Paper Towel Cabinets:

- 1. (PTC-1) Paper Towel Dispensers: Bobrick 262, surface mounted multifold.

C. Soap Dispensers:

- 1. (SDISP-1) Soap Dispensers: Bobrick 2112, surface mounted, horizontal design.

END OF SECTION

SECTION 104400 FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire extinguishers.
2. Fire hose and valve cabinets.
3. Fire blanket cabinets.
4. Combination fire blanket and extinguisher cabinets.
5. Fire extinguishers in cabinets and on wall brackets.

B. Related Sections:

1. Section 099000 - Painting.
2. Division 21 – Fire Suppression: Fire protection system.

1.2 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection cabinets.
1. Fire Extinguishers: Include rating and classification.
 2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
 3. Show location of knockouts for hose valves.
- B. Samples: Submit samples of cabinet finish for color selection, in accordance with Section 013300.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
1. Provide fire extinguishers approved, listed, and labeled by FMG.
- C. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver fire fighting devices in manufacturer's protective packaging as required by project sequencing for installation. Fill and service extinguishers as required before installation.
- B. Store and handle with care to prevent damage.

1.5 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.

1.6 SEQUENCING

- A. Apply vinyl lettering on field-painted fire-protection cabinets after painting is complete.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 FIRE EXTINGUISHERS

- A. Manufacturers: Basis of design: The design for each fire extinguisher is based on the product named. Subject to compliance with the requirements in this Section, other manufacturer's listed may provide products.
 - 1. JL Industries / Activar, Inc.
 - 2. Larsen's Manufacturing
 - 3. Potter Roemer, Div. of Smith Industries, Inc.
 - 4. Kidde Fyrnetics.
 - 5. Nystrom Building Products.
- B. Extinguishers
 - 1. Extinguisher (FE-1): 2-1/2 lb. Type ABC dry chemical.
 - a. JL Industries, Cosmic 2-1/2E,
 - 2. Extinguisher (FE-2): 5 lb. Type ABC dry chemical.
 - a. JL Industries, Cosmic 5E
 - 3. Extinguisher (FE-3): 10 lb. Type ABC dry chemical.
 - a. JL Industries, Cosmic 10E
 - 4. Extinguisher (FE-4): 20 lb, Type "K", Wet Chemical; K class; potassium acetate based, low PH agent.
 - a. JL Industries, Saturn 25
 - 5. Extinguisher (FE-5): 8 lb, Type 2A, 2-1/2 gal, water misting, non-ferrous canister.
 - a. JL Industries, # 272.
- C. Extinguishers shall be charged and bear inspection tag with charge date.

2.2 FIRE EXTINGUISHER CABINETS

- A. Manufacturers: Basis of design: The design for each fire extinguisher cabinet is based on the product named. Subject to compliance with the requirements in this Section, other manufacturer's listed may provide products.
 - 1. J L Industries: www.jlindustries.com / Activar, Inc.: www.activar.com
 - 2. Larsen Manufacturing Company: www.larsensmfg.com
 - 3. Potter Roemer, Div. of Smith Industries, Inc.: www.potterroemer.com
 - 4. Nystrom Building Products.
- B. Fire Extinguisher Cabinets:
 - 1. Fire Extinguisher Cabinet (FEC-1): J L Industries, Ambassador Series No. 2015-V-17.
 - a. Description: Steel cabinet, recessed flat trim, Contemporary V-panel door style with glass.
 - b. Glass Type:
 - 1) Clear tempered safety glass
 - c. Latch:

- 1) Magnetic catch.
 - 2) Cylinder lock
 - d. Labeling: Painted letters vertically.
 - 1) Lettering Color:
 - (a) Red
 - (b) Black
 - e. Finish:
 - 1) Prime painted.
 - 2) Baked enamel finish in color as selected by Architect.
 - f. Extinguisher: FE-3.
- 2. Fire Extinguisher Cabinet (FEC-2): J L Industries, Ambassador Series No. 1016-S21.
 - a. Description: Steel cabinet, semi-recessed with 1-1/2 trim square trim with solid door
 - b. Latch:
 - 1) Magnetic catch.
 - c. Labeling: Vinyl letters vertically.
 - 1) Lettering Color:
 - (a) Red
 - (b) Black
 - d. Finish:
 - 1) Prime painted.
 - 2) Baked enamel finish in color as selected by Architect.
 - e. Extinguisher: FE-3
- 3. Fire Extinguisher Cabinet (FEC-3): J L Industries Ambassador Series No. 2012-F-17.
 - a. Description: Steel cabinet, semi-recessed 4 inch radius return trim with clear door, full glass door.
 - b. Glass Type:
 - 1) Clear tempered glass
 - c. Latch:
 - 1) Magnetic catch.
 - d. Finish:
 - 1) Prime painted.
 - 2) Baked enamel finish in color as selected by Architect.
- 4. Fire Extinguisher Cabinet (FEC-4): J L Industries Panorama Series No. 2025-C71
 - a. Description: Recessed aluminum door frame and steel tub, and flat trim door with clear door.
 - b. Glass Type:
 - 1) Acrylic
 - c. Latch:
 - 1) Magnetic catch.
 - d. Finish:
 - 1) Clear Anodized
 - e. Extinguisher: FE-3
- 5. Fire Extinguisher Cabinet (FEC-5): J L Industries, Academy Series No. 1025-G-17
 - a. Description: Recessed door and flat trim with full glass door.
 - b. Glass Type:
 - 1) Clear tempered glass.
 - c. Latch:
 - 1) Cylinder lock.
 - d. Finish:
 - 1) Clear Anodized
 - e. Extinguisher: FE-3
- 6. Fire Extinguisher Cabinet (FEC-6): J L Industries, Ambassador Series No. 2015-V-17 -FX.
 - a. Description: Fire rated, steel cabinet, recessed flat trim, Contemporary V-panel door style with glass.
 - b. Glass Type:
 - 1) Clear tempered safety glass.
 - c. Latch:
 - 1) Magnetic catch.
 - 2) Cylinder lock

- d. Labeling: Painted letters vertically.
 - 1) Lettering Color:
 - (a) Red
 - (b) Black
 - e. Finish:
 - 1) Prime painted.
 - 2) Baked enamel finish in color as selected by Architect.
 - f. Extinguisher: FE-3.
7. Fire Extinguisher Cabinet (FEC-7): J L Industries, Ambassador, Series No. 1013-G-17
- a. Description: Surface mounted steel cabinet with full glass door.
 - b. Glass Type:
 - 1) Clear tempered glass.
 - c. Latch:
 - 1) Magnetic latch
 - 2) Cylinder lock.
 - d. Finish:
 - 1) Prime painted.
 - 2) Baked enamel finish in color as selected by Architect.
 - e. Extinguisher: FE-3
8. Fire Extinguisher Cabinet (FEC-8): JL Industries, ABS Series, Model ABS 24RR
- a. Description: Constructed of ABS plastic, for exterior or harsh environments. Surface mounted with glass or solid door
 - b. Glass type:
 - 1) Full, clear tempered glass.
 - 2) Horizontal duo, double strength.
 - 3) None, solid plastic door.
 - c. Lock type:
 - 1) Tab for padlock.
 - d. Color: Red
 - e. Extinguisher: FE-3.
9. Fire Extinguisher Cabinet (FEC-9): J L Industries, Ambassador Series No. 2014-V-17.
- a. Description: Steel cabinet, recessed trimless, Contemporary V-panel door style with glass.
 - b. Glass Type:
 - 1) Clear tempered safety glass
 - c. Latch:
 - 1) Magnetic catch.
 - 2) Cylinder lock
 - d. Labeling: Painted letters vertically.
 - 1) Lettering Color:
 - (a) Red
 - (b) Black
 - e. Finish:
 - 1) Prime painted.
 - 2) Baked enamel finish in color as selected by Architect.
 - f. Extinguisher: FE-3.

2.3 FIRE CABINETS AND BLANKETS

- A. Fire Extinguisher Cabinets with Fire Blanket (FBC-1): Larson's, Series 3612-RL
 - 1. Description: Steel cabinet, semi-recessed mounted, 2-1/2 inch projection with solid door style with magnetic catch.
 - a. Labeling: Vinyl letters horizontally.
 - 1) Lettering Color:
 - (a) Red
 - (b) Black
 - b. Finish:
 - 1) Prime painted
 - 2) Baked enamel finish in color as selected by Architect.

- c. Provide fire extinguisher, FE-3.
- d. Fire Blanket: Comply with FS CS-191-53.
 - 1) Size: 62"x 80"
- 2. Manufacturers:
 - a. J L Industries / Activar, Inc.
 - b. Larsen Manufacturing.
 - c. Nystrom Building Products.
- B. Fire Blanket Cabinet (FBC-2): J L Industries, Royal Series 1FB, Enclosed blanket is attached to the vertical roller and comes with arm loops to enable a person to wrap themselves in the blanket in one continuous motion with red epoxy cold rolled steel door.
 - 1. Blanket: Comply with Flammable Fabrics Act: Flammability of Clothing Textiles, Title 16, CFR1610, 100 percent reprocessed wool fire blanket.
 - 2. Finish: Baked enamel finish in color as selected by Architect.
 - 3. Surface mounted.
 - 4. Manufacturers:
 - a. Larsen Manufacturing
 - b. JL Industries / Activar, Inc.
 - c. Nystrom Building Products.

2.4 FIRE HOSE AND VALVE CABINETS

- A. Fire Hose Cabinet (FHC-1): Fire Hose and Extinguisher Cabinet, Larsen, Occult Series No. O-3232.
 - 1. Description: Steel cabinet, recessed with solid door with vertical glazed window, and flat trim, capable of holding 100 foot hose and 1 fire extinguisher.
 - 2. Glass: Clear double strength.
 - 3. Latch:
 - a. Magnetic catch with standard pull.
 - 4. Finish:
 - 1) Prime painted.
 - 2) Baked enamel finish in color as selected by Architect.
 - 5. Extinguisher: FE-3
 - 6. Manufacturers:
 - a. Larsen Manufacturing
 - b. JL Industries / Activar, Inc.
 - c. Nystrom Building Products.
- B. Fire Valve Cabinet (FVC-1): Larsen, Series No. VC-1818.
 - 1. Description: Steel cabinet, recessed with flat trim and full glass door.
 - 2. Glass: Clear double strength.
 - 3. Latch:
 - a. Magnetic catch with standard pull.
 - 4. Finish:
 - 1) Prime painted.
 - 2) Baked enamel finish in color as selected by Architect.
 - 5. Manufacturers:
 - a. Larsen Manufacturing
 - b. JL Industries / Activar, Inc.
 - c. Nystrom Building Products.

2.5 FIRE EXTINGUISHER MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 1. Color: Black.
 - 2. Manufacturers:
 - a. Larsen
 - b. JL Industries / Activar, Inc..

- c. Potter Roemer
- d. Kidde Fynetics.
- e. Nystrom Building Products.

2.6 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Weld joints and grind smooth.
 - 2. Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- thick, cold-rolled steel sheet lined with minimum 5/8-inch- thick, fire-barrier material.
 - a. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
 - 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 - 2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for hose valves and cabinets to verify actual locations of piping connections before cabinet installation.
- B. Examine walls and partitions for suitable framing depth and blocking where recessed and semi-recessed cabinets will be installed.
- C. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged units.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fire protection specialties and accessories according to reviewed shop drawings and manufacturer instructions.
- B. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.
 - 1. Provide inside latch and lock for break-glass panels.
 - 2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
- D. Install in locations and at mounting heights indicated or, if not indicated, at heights to comply with applicable regulations of governing authorities.
- E. Prepare recesses in walls for cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.
- F. Identification: Apply vinyl lettering at locations indicated.

- G. Owner will furnish and install fire extinguishers.

3.3 INSTALLATION OF FIRE-RATED HOSE/VALVE CABINETS

- A. Install cabinet with not more than 1/16-inch tolerance between pipe OD and knockout OD. Center pipe within knockout.
- B. Seal through penetrations with firestopping sealant as specified in Division 7 Section "Through-Penetration Firestop Systems."

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 115313 LABORATORY FUME HOODS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Furnishing and installing Chemical Fume Hoods, Fume Hood Base and Special Cabinets as shown on the drawings and as specified herein.

B. Related Sections:

1. Section 123553.16: Plastic Laboratory Casework and Furnishings.
2. Division 22: Furnishing and installation of plumbing utilities and final connections to fume hoods.
3. Division 23: Furnishing and installation of exhaust duct work and equipment, and final connection of fume hoods.
4. Division 23: Furnishing and installation of exhaust controls and final connections to hoods.
5. Division 26: Furnishing and installation of electrical utilities and final connections to fume hoods.

1.2 DESIGN REQUIREMENTS

- A. Fume hoods must be Underwriters Laboratories 1805 Classified.
- B. Fume hoods shall function as ventilated, enclosed work spaces, designed to capture and confine exhaust fumes, vapors and particulate matter produced or generated within the enclosure.
- C. Design fume hoods for consistent and safe air flow through the hood face. Negative variations of face velocity shall not exceed 10 % of the average face velocity at any designated measuring point as defined in this section.
- D. Fume hood shall be designed to minimize static pressure loss with adequate slot area and bell shaped exhaust collar configuration.
- E. Fume hoods shall be constructed in such a manner as to cause no perceptible increase in sound pressure level over the mechanical exhaust system.
- F. Provide seismic anchorage in accordance with the local governing structural codes.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each type of fume hood specified. Include component dimensions, configurations, construction details, joint details, and attachments. Indicate location, size, and service requirement for each utility connection.
- B. Shop Drawings:
 1. Submit shop and fabrication drawings stamped by a licensed Professional Engineer. This engineer shall perform and submit structural calculations to document the fume hood systems and proper anchorage to building components.
 2. Provide 3/4 inch = 1'-0" scale elevations of individual and battery of fume hoods showing cross sections, rough-in and anchor placements, tolerances, and clearances. Indicate relation to other laboratory equipment, surrounding walls, windows, doors, and other building components.
 3. Provide 1/4 inch = 1'-0" rough-in plan drawings for coordination with trades.
 4. Provide 3 full size sets of black line shop drawing prints.
- C. Finish Samples: Submit 3 inch by 5 inch samples of color of finish for fume hoods, and for other pre-finished equipment and accessories for selection by Owner's Representative.
- D. Test Reports: Submit test reports verifying conformance to specified performance tests.
- E. UL 1805: Submit written verification of compliance to UL 1805.

- F. Life Cycle Tests: Provide independent test data for sash hardware components such as cables and pulleys.
- G. Manufacturer's Qualifications: Provide documentation from Fume Hood Manufacturer indicating they have supplied for installation, the product described in this section on six (6) similar projects in the past three (3) years.
- H. Maintenance Manuals: Provide written instruction manuals outlining operating and safety instructions and proper maintenance procedures.

1.4 QUALITY ASSURANCE

- A. Single Source Responsibility: Fume hoods, casework, work surfaces, laboratory furnishings, and accessories shall be furnished by a single laboratory furniture company.
- B. Manufacturer's Qualifications: Modern plant with proper tools, dies, fixtures, and skilled production staff to produce high quality laboratory casework and equipment, and shall meet the following minimum requirements:
 - 1. Five years or more experience in manufacture of laboratory casework and equipment of type specified.
 - 2. Ten installations of equal or larger size and requirements in the previous three years.
- C. Installer's Qualifications: Factory trained and certified by the manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Schedule delivery of fume hoods and equipment so that spaces are sufficiently complete that material can be installed immediately following delivery.
- B. Storage: If fume hoods must be stored in other than installation areas, store only in areas where it will prevent damage or soiling of fume hoods.
- C. Handling: Keep covered with polyethylene film or other protective coating as necessary to protect fume hood from soiling or damage during handling and installation.

1.6 PROJECT CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met:
 - 1. Building areas requiring the installation of fume hoods shall be dry and unexposed to adverse weather conditions which may damage finished materials.

1.7 SEQUENCING AND SCHEDULING

- A. All overhead mechanical, electrical and plumbing rough-in work shall be complete prior to fume hood delivery.
- B. All mechanical, electrical and plumbing rough-in work required is to be complete prior to delivery of materials.
- C. Walls and partitions must be in place and finished with at least the primer coat of paint. If finish painting is to take place after laboratory furnishing installation, protect the fume hoods by covering and masking prior to commencement.
- D. All necessary blocking or backing must be installed within wall partitions prior to delivery of casework and furnishings.
- E. Ceiling grid must be in place prior to fume hood installation.
- F. Overhead lighting must be installed and connected prior to casework installation.
- G. All flooring required to be placed under lab casework and furnishings must be installed prior to material delivery and casework installation.
- H. Wet operations to be performed must be complete prior to material deliveries.

1.8 WARRANTY

- A. Provide a 1-year warranty against defects in materials and workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 1. Jamestown Metal Products, Inc.
Jamestown, New York 14701
(701) 665-5313
www.Jamestown.com
 2. Lab-conco Corporation
Kansas City, Missouri 64132
(800) 821-5525
www.labconco.com
 3. Kewaunee Scientific Corporation – Laboratory Division
Statesville, North Carolina 28677
(704) 873-7202
www.kewaunee.com
 4. ThermoFisher Scientific (formally Fisher Hamilton)
Two Rivers, Wisconsin 54241
(920) 793-1121
www.hamiltonlab.com
 5. Or Equal
- B. Casework, furnishings and equipment specified in the following sections shall be furnished and installed by the same supplier contracted for:
 1. Section 123553.16: Plastic Laminate Laboratory Casework and Furnishings

2.2 MATERIALS

- A. Sheet Steel:
 1. Metallic Furniture Stock: ASTM A-1008 mild steel, cold rolled, pickled, double annealed, and free from rust, scales, scratches, buckles, ragged edges, and other defects.
- B. Stainless Steel:
 1. Type 304: ASTM A240; exposed surfaces ground and polished to a Number 4 finish.
 2. Type 316: ASTM A240; exposed surfaces ground and polished to a Number 4 finish.
 3. Welding: All stainless steel welding material shall be of type similar to sheet material. Welds shall be ground, polished, and a subsequent passivation process utilized to blend harmoniously with a Number 4 satin finish without discoloration.
- C. Epoxy Resin:
 1. As specified in Section 123553.16
- D. Glasses:
 1. Clear laminated safety glass
 2. Tempered

2.3 BENCHTOP CHEMICAL FUME HOODS

- A. Underwriters Laboratories 1805 Classified. Provide labeling affixed to the face of each fume hood indicating classification to the UL 1805 standard for laboratory fume hoods.

B. Superstructure:

1. Wall: Rigid, self supporting assembly of double wall construction, maximum 5 inches thick. Double wall shall consist of a sheet steel outer shell and a corrosion resistant inner liner and shall house and conceal steel framing members, attaching brackets and remote operating service fixture mechanisms and services. Hoods shall be completely factory assembled to form a rigid, self-supporting structure.
2. Face Opening: Air foil or streamlined shape with all right angle corners radius or angled.

C. Exterior Bypass: 18 gage steel low resistance type. Bypass air shall enter at an opening at the top front superstructure or through upward directional louvers in the upper front exterior panel.

D. Interior Bypass:

1. Designed to limit variations to the face velocity regardless of sash position. Bypass shall be sufficiently sized for the fume hood configuration and type.
2. Restricted Bypass: Provide a restricted bypass on all variable air volume (VAV) or constant air volume (CV) fume hoods with combination sashes and on all variable air volume fume hoods with a vertical rising sash.
3. Non-Restricted Bypass: Provide a non-restricted bypass on all constant air volume hoods with a vertical rising sash.
4. Bypass Material: Manufactures standard material. If constructed from steel, provide with a urethane powder coat finish to match color of hood liner.

E. Ceiling Closure Panel: Used to enclose the space between the top of the fume hood and the ceiling. Provide a 1 inch gap between the closure and the ceiling. Minimum 18 gage thick steel, finished to match fume hoods exterior. Provide with a removable front panel for access to the fume hoods lights, piping and exhaust duct connection.

F. Filler Panels: Provide side panel(s) where side of unit is visible in room, provide a continuous 2 to 3 inch wide filler panel(s) along side of unit at wall(s) per plan condition; finish filler panel to match unit.

G. Fastenings:

1. Exterior structural member attachments: Sheet metal screws, zinc plated.
2. Interior fastening devices concealed. Exposed screws not acceptable.
3. Exterior panel member fastening devices concealed. Exposed screws not acceptable.

H. Sill:

1. Flush bypass type designed to prevent reverse air flow or air eddies at the fume hood work surface. Sill to include an integral spill trough with hinged panels for access to trough and that allows pass thru of hospital grade electrical plugs. Mount sill assembly flush with bottom of fume hood work surface. Provide a chemical resistant sealant between sill and work surface.
2. Construct using 16 gage, Type 304 stainless steel with an acid and abrasion resistant paint coating applied by an electro-deposition process.
3. Color: Selected by the Owner's Representative.

I. Sashes:

1. Full view type with clear, unobstructed, side to side view of fume hood interior and service fixture connections. Refer to the Fume Hood Schedule on the Drawings for type and height of sash at each fume hood.
2. Vertical Sliding Sash:
 - a. 2 inches maximum height bottom sash rail, 18 gage thick steel with a polyurethane powder coat finish. Provide integral formed flush pull the full width of bottom rail. Set safety glass into rails in deep form, extruded polyvinyl chloride glazing channels. Open and close sash against rubber bumper stops.
 - b. Sash Operation: Counterbalanced cable and pulley arrangement or counterbalanced chain and sprocket system. Sash shall move smoothly without tilting or binding and shall remain at rest in any open position.

- c. Sash Stops: Provide sash stops at operating sash opening or design sash opening. Refer to the fume hood schedule for requirements. Sash stops shall be the type that allows for it to be manually overridden. Provide an acid resistant decal indicating the operating or design sash opening.
3. Sash Glass: 7/32 inch thick laminated safety glass.
4. Sash Guides: Corrosion resistant polyvinyl chloride.

J. Liners:

1. Polyester Liner: Reinforced glass polyester panel; smooth finish and white color in final appearance. Flexural strength: 21,000 psi (144,790 kPa). Flame spread: 25 or less per UL 723 and ASTM E84-80. Manufactured by Rochling-Glastic, Haysite, Morrison Molded Fiberglass, WS Hampshire Inc. "Wesliner 1125". Provide gasketed access panels in the liner for access to valves and fixtures. Panels shall be of the same material as the liner and be provided with a PVC gasket to eliminate air leakage and retain liquids inside the hood.

K. Baffles :

1. Provide fixed baffles in the rear of the fume hoods interior chamber to control airflow distribution within the hood and through the face opening. Fabricate of the same material as the liner. All baffle supports/brackets to be nonmetallic.
2. Baffle designs which permit close off of all slots are not acceptable.
3. Must comply with OSHA Lab Standard Guidelines.

L. Work Surfaces:

1. Material: 1-1/4 inch epoxy resin thick with a 3/8 inch dished area within the fume hood interior work surface to contain spills. Work surface as manufactured by The Durcon Company, Inc.; or Epoxyn Products. Color to be selected by the Owner's Representative from the manufacturer's standard colors.

M. Sinks:

1. Cup Sink: As specified in Section 123553.16

N. Service Fixtures and Piping:

1. Fume hoods shall be factory pre-piped in accordance to all state and local codes. Refer to the Drawings for services required at each fume hood. Terminate piping 2 inches above the fume hood roof for in-the-field point of connection. Install protective rubber piping end caps for shipment. Piping materials and installation for each type of service shall be as specified under Division 22. Pressure test all pre-piped lines in the factory.
2. Control Valves: Control valves shall be mounted on the front panel of the fume hood, with all components subject to wear accessible from the exterior of the hood. Straight or 45 degree angle mounted fixtures are acceptable. The centerline of the valve inlet and outlet shall be parallel and 1-1/8 inches apart. Valves shall have a threaded collar to hold the valve in place.
3. Service fixtures outlets within the fume hoods interior shall have color coded, acid and solvent resistant plastic coating, applied over fine sandblasted surface, properly cleaned. Surfaces to be coated shall be sprayed and baked three times with minimum coating thickness of 6 mil.
4. Color coding of hood interior service fixtures and remote control valves shall be as specified in Section 123553.16.

O. Electrical:

1. Factory install receptacles, lighting, electrical fixtures and wiring in accordance with all applicable state and local codes and Division 26 specifications. Terminate wiring in a single service junction box on top of the fume hood roof for in-the-field point of connection. All electrical fixtures shall be UL listed and labeled.
2. Receptacles:
 - a. Unless otherwise noted, provide each hood with receptacle quantities as follows:
 - 1) 48 inch wide hoods: Provide one duplex receptacle each side post near the bottom.
 - 2) 60 inch wide and greater hoods: Provide two (2) duplex receptacles each side post near the bottom. Receptacles on each side shall be wired alternately.
 - 3) Provide a dedicated receptacle on top of all hoods for safety monitor and alarm.

- b. Receptacle: NEMA-5-20R, three wire grounding type receptacle rated at 120VAC at 20 AMP with ground fault interruption (GFI), Gray in color with a stainless steel brushed finish flush face plate. Install receptacles with the ground outlet above the power slots. Label each receptacle per Division 26 specifications with the associated circuit number.

3. Lighting:

- a. Fixture: Two (2) lamp, rapid start, UL listed fluorescent light fixture with sound rated ballast installed on the exterior of fume hood roof. Provide light fixture isolated from the hood interior by 1/4 inch thick laminated safety glass panel cemented and sealed to the hood roof. The lighting shall be serviceable from outside the fume hood interior.
- b. Interior Fixture Finish: White, high reflecting plastic enamel.
- c. Size: Largest possible up to 48 inches for hoods with superstructures up to 6 feet. Provide (2) 36 inch fixtures for hoods with 8 foot superstructures.
- d. Lamps: Include lamps with fixtures.
- e. Illumination: 80 footcandle minimum average at the worksurface.
- f. Light Switch: Toggle type, single pole 120 VAC, 20 AMP, Gray in color with stainless steel brushed finished flush face plate. Mount on left side of fume hood side post.
- g. Lamps and ballast to be the same type as specified in Division 26 for the general overhead lighting in laboratory spaces.

P. Exhaust Outlet:

1. Collar: Rectangular or round, 18 gage thick minimum. Fabricate collar of the same material as the building exhaust duct connection.
2. Duct Transition: For fume hoods with rectangular duct collars, provide exhaust duct transition from the fume hood rectangular exhaust collar to the building exhaust system round duct connection. Round duct size as indicated in the Fume Hood Schedule. Fabricate transition of the same material as the exhaust outlet.

Q. Safety Monitor/Alarm System:

1. Variable Air Volume Hoods: Each fume hood shall be equipped with a velocity control and safety audible/visual alarm unit which is to be provided under Division 23. Provide factory cut outs in the front of the hood for field mounting of the unit. Coordinate location and size of cut out with Division 23. Connection of control and safety alarm unit to sensors and control valves shall be under Division 23.

R. Operation Instructions:

1. Provide a permanent acid resistant decal or plate attached to fume hood exterior with condensed information covering the following:
2. Recommended locations for apparatus and accessories
3. Recommended safe operating procedures.
4. Use of sash

S. Fume Hood Information/Certification Holder:

1. Provide a 4 inch by 6 inch corrosion resistant metal or plastic frame attached to front face of fume hood exterior with plastic or glass glazing to contain a removable data card to identify hood, show hood characteristics and field test data. Data card will be provided by others.

T. Unit will be equal to Concept as manufactured by ThermoFisher Scientific.

2.4 FUME HOOD BASE AND SPECIAL CABINETS

A. Flammable Liquids Storage Cabinet:

1. Conform to OSHA Regulations and the requirements of NFPA 30-2003 Chapter 6-3, National Fire Protection Association, Flammable and Combustible Liquids Code. Cabinets shall be Factory Mutual (FM) approved or Underwriters Laboratories (UL) listed. Cabinets shall limit the internal temperature at the center, 1 inch from the top to not more than 325 degrees Fahrenheit when subjected to a ten-minute fire test that simulates the fire exposure of the standard time-temperature curve specified in NFPA 251.

2. Casing: Bottom, top, back, door, and sides of cabinet shall be at least 18 gage sheet steel, double walled with 1-1/2 inch air space. Joints shall be welded airtight. Provide with adjustable zinc plated leveling legs.
3. Door: Provide with continuous piano hinge and a 3—point latching arrangement with door sill raised at least 2 inches above the bottom of the cabinet to retain spilled liquid within the cabinet. When more than 1 door is used, there shall be a rabbetted overlap of not less than 1 inch. Provide self closing latching door(s) with fusible link(s) to hold doors wide open and melt at 165 degrees Fahrenheit for automatic closure.
4. Ventilation: Do not ventilate cabinet unless required by local authorities. Seal vent openings with plugs supplied by the manufacturer if ventilation is not required. Provide flame arrestor on cabinet vent outlets if ventilation is required.
5. Shelving: Provide each cabinet with one full width, full depth removable/adjustable metal shelf. Provide with "locking" clips to avoid inadvertent removal.
6. Grounding: Provide a grounding lug connection at back of cabinet. Coordinate connection with Division 16.
7. Identification: Apply silkscreen signage, color red, in a conspicuous size to cabinet doors indicating "FLAMMABLE – KEEP FIRE AWAY".
8. Finish as specified for Metal Finish in this specification section. Color selected by the Owner's Representative.

B. Corrosive Storage Cabinet:

1. Construction: Bottoms, top, back, door, and sides of cabinet shall be 18 gage sheet steel, double walled with 1-1/2 inch air space. Joints shall be welded airtight. Provide with adjustable zinc plated leveling legs.
2. Ventilation: Provide a 2 inch polypropylene vent pipe at the outside rear of the cabinet with two inlets, one high and one low. Secure vent pipe inlets to back of cabinet with polypropylene locking nuts. Extend vent pipe 4 inches above the work surface behind the fume hood baffle.
3. Doors: Provide with louvered vents near bottom of each door and polypropylene or ABS roller catches with stainless steel screws.
4. Bottom: Provide with 1/4 inch thick heat welded, polypropylene or ABS plastic pan, liquid tight removable, 1 inch deep.
5. Shelving: Provide with a half depth, adjustable shelf for the full width of the cabinet with polypropylene shelf clips.
6. Finish as specified for Metal Finish in this specification section. Color selected by the Owner's Representative.
7. Identification: All under-counter ventilated cabinets shall be marked with conspicuous lettering: "CAUTION-ACIDS/CORROSIVES".

C. Sink Cabinets:

1. End Panels and Backs: 18 gage steel. End panels and back formed from a single steel sheet with front edges formed to a channel shape and further offset to form a strike for doors and drawers. Removable partial height back panels to allow passage of drain line and piping to service chase.
2. Bottoms: 18 gage steel. Bottom and bottom rail formed from a single piece of metal with both sides and back formed up with a radius between flange and bottom for ease of cleaning. Form front rail to provide a strike for drawers. Reinforce at front corners with 15 gage gusset.
3. Front Top Rails: 16 gage steel. Provide flush at face of cabinet and interlock within the flange at the top of the end panels.
4. Toespace Rails: 18 gage steel. Install between end panels to provide a minimum toespace of 3 inches deep by 4 inches high. Provide 11 gage steel corner gussets at front and rear corners with 3/8 inch diameter leveling screws integral with bottom flange.
5. Doors: Flush inset type with 3/4 inch double wall assembly with 18 gage exterior panel and 20 gage interior panel. Reinforce interior of front panel with welded steel hat channels. Prepaint and sound deaden interior. Weld outer corners and grind smooth. Doors shall close against rubber bumpers.
6. Finish as specified for Metal Finish in this specification section. Color selected by the Owner's Representative.

2.5 METAL FINISH

- A. Preparation: Spray clean metal with a heated cleaner / phosphate solution, pre-treat with iron phosphate spray, water rinse, and neutral final seal. Immediately dry in heated ovens, gradually cool, prior to application of finish.
- B. Application: Electro-statically apply epoxy or urethane powder coat of selected color and bake in controlled high temperature oven to ensure a smooth, hard satin finish. Surfaces shall have a chemical resistant, high grade laboratory furniture quality finish of the following thicknesses:
- C. Exterior and interior surfaces exposed to view: 1.5 mil average and 1.2 mil minimum.
- D. Surfaces not exposed to view: 1.0 mil average.
- E. Color(s) selected by Owner's Representative.

2.6 SOURCE QUALITY CONTROL TESTING OF EPOXY RESIN WORK SURFACE

- A. As specified in Section 123553.16

2.7 SOURCE QUALITY CONTROL TESTING OF POLY RESIN LINER

- A. Test Procedure:
 - 1. Test Number 1 - Spills and Splashes:
 - a. Suspend in a vertical plane a 42 inch (horizontal) by 12 inch (vertical) panel divided into 3/4 inch wide vertical columns.
 - b. Apply 5 drops of each reagent listed with an eye dropper.
 - c. Apply liquid reagents at top of panel and allow to flow down full panel height. (CAUTION! Flush away any reagent drops.)
 - 2. Test Number 2 - Fumes and Gases:
 - a. Divide 24 inch by 12 inch panel into 2 inch squares.
 - b. Place 25 milliliters of reagent into 100 milliliter beakers and position panel over beaker tops in the proper sequence. Note: Beaker pouring lip permits atmospheric oxygen to enter and participate in the reaction of the reagent fumes.
- B. After 24 hours remove panel, flush with water, clean with naphtha and detergent, rinse, wipe dry and evaluate.
- C. Evaluation ratings: Change in surface finish and function shall be described by the following ratings:
 - 1. No Effect: No detectable change in surface material.
 - 2. Excellent: Slight detectable change in color or gloss, but no change to the function or life of the work surface material.
 - 3. Good: Clearly discernible change in color or gloss, but no significant impairment of work surface function or life.
 - 4. Fair: Objectionable change in appearance due to surface discoloration or etch, possibly resulting in deterioration of function over an extended period.
 - 5. Failure: Pitting, cratering or erosion of work surface material; obvious and significant deterioration.
- D. Test Results: Submit a report of the test results. The results shall be equal to or better than the following:

REAGENT LIST	TEST	1 TEST	2
<u>CONCENTRATIONS BY WEIGHT RATING</u>		<u>SPILLS</u>	<u>FUMES</u>
1. Sodium Hydroxide	Flake	No Effect	No Effect
2. Sodium Hydroxide	40%	No Effect	No Effect
3. Sodium Hydroxide	20%	No Effect	No Effect
4. Sodium Hydroxide	10%	No Effect	No Effect
5. Ammonium Hydroxide	28%	No Effect	No Effect
6. Methylene Chloride	No	Effect	Effect
7. Chloroform	No	Effect	Effect

8. Carbon Tetrachloride	No	Effect	No	Effect
9. Monochlorobenzene	No	Effect	No	Effect
10. Tincture of Iodine		No Effect		Good
11. Methyl Alcohol	No	Effect	No	Effect
12. Ethyl Alcohol	No	Effect	No	Effect
13. Butyl Alcohol	No	Effect	No	Effect
14. Phenol, 85%	No	Effect		Excellent
15. Cresol	No	Effect	No	Effect
16. Sodium Sulfide	No	Effect	No	Effect
17. Furfural	Excellent			Excellent
18. Dioxane	No	Effect	No	Effect
19. Zinc Chloride	No	Effect		Excellent
20. Benzene	No	Effect	No	Effect
21. Toluene	No	Effect	No	Effect
22. Xylene	No	Effect	No	Effect
23. Gasoline	No	Effect	No	Effect
24. Naphthalene	No	Effect	No	Effect
25. Methyl ethyl Ketone	No	Effect	No	Effect
26. Acetone	No	Effect	No	Effect
27. Ethyl Acetate	No	Effect	No	Effect
28. Amyl Acetate	No	Effect	No	Effect
29. Ethyl Ether	No	Effect	No	Effect
30. Silver Nitrate, 10%	Excellent			Excellent
31. Dimethylformamide	Excellent			Excellent
32. Formaldehyde, 37%	No	Effect	No	Effect
33. Formic Acid, 88%	No	Effect		Excellent
34. Acetic Acid, Glacial		No Effect		No Effect
35. Dichloroacetic Acid	No	Effect		Excellent
36. Chromic Acid, 60%		No Effect		No Effect
37. Phosphoric Acid, 85%		No Effect		No Effect
38. Sulfuric Acid, 33%		No Effect		Excellent
39. Sulfuric Acid, 77%		No Effect		No Effect
40. Sulfuric Acid, 93%		No Effect		No Effect
41. Hydrogen Peroxide, 30%		No Effect		No Effect
42. Acid Dichromate	No	Effect	No	Effect
43. Nitric Acid, 20%		No Effect		Excellent
44. Nitric Acid, 30%		No Effect		No Effect
45. 40 & 47 Equal Parts		No Effect		Good
46. Nitric Acid, 70%		No Effect		Good
47. Hydrofluoric Acid, 48%		No Effect		Excellent
48. Hydrochloric Acid, 37%		No Effect		Excellent

2.8 SOURCE QUALITY CONTROL TESTING OF FUME HOODS

- A. Submit a test report, for each type and size of hood, for the standard product previously tested, if the product is identical to equipment being provided for this project.
- B. Evaluation of standard product shall have been conducted in the manufacturer's test facility in accordance with the method prescribed in ANSI/ASHRAE 110-1995.
- C. Hoods shall achieve a rating of 4.0 AM 0.05 with 4.0 being the tracer gas release rate in liters per minute, AM identifying an "As Manufactured" test, and 0.05 indicating the maximum level of tracer gas, in parts per million, in the breathing zone.

2.9 SOURCE QUALITY CONTROL TESTING OF FUME HOOD SOUND LEVELS

- A. Provide the following historic certified sound test data for each size and type of fume hood:
 1. Background sound pressure level readings for the test facility with exhaust system operating but without connection to the fume hood.

2. A second set of readings recorded with the fume hood connected and operating and the sensor located 36 inches in front of the sash assembly.
3. Certified report: Octave band sound pressure level, Db re 20 micro Pa in the 31.5 to 8,000 Hertz frequency range, for the fume hood operating.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation:

1. Install fume hoods and equipment in accordance with manufacturer's instructions.
2. Install equipment plumb, square, and straight with no distortion and securely anchored as required.
3. Secure work surfaces to casework and equipment components with material and procedures recommended by the manufacturer.

B. Accessory installation: Install accessories and fixtures in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL TESTING OF FUME HOODS

A. Testing Requirements:

1. Perform tests in field to verify proper operation of the fume hoods before they are put in use, using only qualified personnel.
2. Perform tests after installation is complete, the building ventilation system has been balanced, all connections have been made, and written verification has been submitted that the above conditions have been met.
3. Verify that the building makeup air system is in operation, the doors and windows are in normal operating position, and that all other hoods and exhaust devices are operating at designed conditions.
4. Correct any unsafe conditions disclosed by these tests before request of test procedures.
5. Provide written results of each fume hood test.

B. Testing Equipment:

1. Properly calibrated hot wire thermal anemometer.
2. Supply of 30 second smoke bombs.

C. Face Velocity Testing:

1. Provide face velocity measurements as outlined in Articles 6.2, 6.3 and 6.4 of ANSI/ASHRAE 110-1995 or latest edition.

D. Smoke Testing:

1. With sash in the open position check airflow into the fume hood using a smoke source. Verify that airflow is into the fume hood over the entire face area by a complete traverse of the fume hood 6 inches (150 mm) inside the face. Reverse flow is evidence of unsafe conditions. Take necessary corrective actions and retest.
2. Move a lighted smoke bomb throughout the fume hood work area directing smoke across the work surface and against the side walls and baffle. Verify that smoke is contained within the fume hood and rapidly exhausted.

3.3 ADJUSTING

- A. Repair or remove and replace defective work, as directed by The Architect upon completion of installation.
- B. Adjust sash, fixtures, accessories and other moving or operating parts to function smoothly.

3.4 CLEANING

- A. Clean equipment, touch up as required.

3.5 PROTECTION OF FINISHED WORK

- A. Provide all necessary protective measures to prevent damage to equipment from exposure to other construction activity.
- B. Advise Contractor of procedures and precautions for protection of material and installed fume hoods from damage by work of other trades.

END OF SECTION 115313

SECTION 122126 BLACKOUT BLINDS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Black out shades at windows where indicated.
- B. Related Sections:
 - 1. Section 122113 – Horizontal Louver Blinds.

1.2 SUBMITTALS

- A. Shop Drawings: Submit shop drawings in accordance with Section 013300. Include layout drawing indicating width and length of window opening, and width and length of shades.
- B. Samples: Submit samples of shade fabric.
- C. Product Data: Submit manufacturer's product data and installation instructions.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Experienced installer who has completed installation of blackout shades similar in material, design, and extent to that indicated for this Project, and whose work has resulted in successful in-service performance.

1.4 PRODUCT HANDLING

- A. Deliver shades in factory packages, marked with manufacturer and product name, and location of installation.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install blackout shades until construction and wet finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at levels indicated for Project when occupied for its intended use.

PART 2 PRODUCTS

2.1 SHADES

- A. (WT-3) Type and Manufacturer: Lightbloc #SB9000 blackout shade system by Draper Shade.
- B. Other Acceptable Manufacturers: Mecho Shade.
- C. Provide complete system with side angles, bottom bar, head box, sponge liner, roller tube, clutch operator, and necessary accessories and fasteners.

2.2 SHADE FABRIC

- A. Blackout Shade Fabric: Glass fabric vinyl covered, washable, fire retardant type Sunbloc #SB 9000, in black color.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which shades are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install blackout shades in accordance with reviewed shop drawings and manufacturer's printed instructions.
- B. Install level and securely mounted.
- C. Clean components of shades to turn over complete and finished product.
- D. After installation adjust operating hardware of track, and hang of shades to insure smooth operation and proper appearance.

3.3 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner maintenance personnel to adjust, operate, and maintain system.

END OF SECTION

SECTION 122216 DRAPERY TRACK AND ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formed steel channel (Extruded aluminum) tracks.
2. Nylon sliding carriers, cords, and accessories.

B. Related Sections:

1. Section 055000 - Metal Fabrications: Above ceiling supports.
2. Section 061000 - Carpentry: Wood blocking to receive anchors.
3. Section 122200 - Draperies and Curtains.

1.2 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013300.
- B. Indicate each track location, width of window opening, appurtenances and interferences, and support bracket details.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer and Type: Double Duty Series 9095 (Architrac Series 94003) - wall (ceiling) mounted by Kirsch Company.
- B. Other Acceptable Manufacturers: Graber Company, O.B. Masco.

2.2 MATERIALS

- A. Tracks: Bi-parting (Side stacking) operating traverse rods, regular (heavy duty) channel track.
- B. Carriers: Nylon roller 3 per foot type.
- C. Cords: Heavy duty, nylon (polypropylene) (cotton) weave.
- D. Tension Pulley: Nylon rollers in metal (plastic) retainer, wall or floor bracket.
- E. Brackets: Formed steel wall (ceiling) type, with screws and inserts for attachment.

2.3 FINISHES

- A. Exposed Metal: Baked enamel, white. (Etched and clear anodized AA-C22-A21).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Extend track 12 inches both sides of window trim for single track, 18 inches for double track where exposed.
- B. Mount track support system on solid backing. Where mounting location does not align with solid backing, provide expanded drywall type anchors for each screw hole location.

C. Anchor tension pulley to wall (baseboard) (floor).

D. Set cord pulls so that pull falls 12 inches below window sill in full open position.

3.2 SCHEDULE

A. Locate single track system at _____.

B. Locate double track system at _____.

END OF SECTION

SECTION 123213 MANUFACTURED WOOD-VENEER-FACED CASEWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood casework, including prefabricated, prefinished base cabinets, wall-mounted units, and full height cases, drawers and bases, aprons, back panels, and filler panels.
2. Woodwork benches with legs, markerboard panels, rubber bumpers and other required accessories and supports.
3. Counter tops, backsplashes, including plastic laminate, modified epoxy resin, resin sinks, and stainless steel with filler panels and scribe pieces.
4. Shelving, including wall shelving, shelf standards and brackets.
5. Casework hardware, pulls, hinges, catches and locks.
6. Preparation of casework for mechanical sinks and accessories.

B. Related Sections:

1. Section 064000 – Architectural Woodwork: Wood cabinetwork.
2. Section 096500 - Resilient Flooring: Vinyl base.
3. Section 123100 - Metal Casework.
4. Section 123216 - Plastic Laminate Faced Casework.
5. Division 23 - Mechanical: Sinks, fixtures and accessories.
6. Division 26 - Electrical: Lights, connection to building services.

1.2 DEFINITIONS

- A. Exposed Portions of Casework: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches above floor, and visible surfaces in open cabinets or behind glass doors.
1. Ends of cabinets indicated to be installed directly against walls or other cabinets, shall be considered exposed.
- B. Semi-Exposed Portions of Casework; Surfaces behind opaque doors, such as interiors of cabinets, shelves, dividers, interiors and sides of drawers, and interior faces of doors. Tops of cases 78 inches or more above floor are defined as semi-exposed.
- C. Concealed portions of casework include sleepers, web frames, dust panels, and other surfaces not visible after installation.

1.3 SUBMITTALS

A. Shop Drawings and Product Data: Submit in accordance with Section 013300.

1. Include component dimensions, configurations, service run spaces, elevations, construction details, and attachments. Provide rough-in drawings prior to other shop drawings if necessary to prevent delays.
2. Locate critical studs from grid lines for mounting or anchoring casework, including shelving. Locate stud within 4 inches in from end of wall case.

B. Samples: Submit in accordance with Section 013300.

1. Provide three 6 inch by 6 inch samples of countertop finish of each color on its base material, plastic laminate, [modified epoxy resin] or other finish for color selection and appearance acceptance.
2. Submit one full size sample finished base cabinet unit, complete with hardware, doors and drawers, without finished top. Acceptable unit may be used in casework. (Submit one 2 foot by 22 inch deep drawer and cupboard base unit, one sink, and one piece of each hardware item.)

- C. Maintenance Manuals: Submit in accordance with Section 013300.
- D. Tests Reports: (Test reports shall be conducted by independent testing agency. Reports shall indicate testing procedures and certify findings.) Submit certified reports of following tests promptly after award of contract and prior to shop drawing submittal:
 - 1. Submit report certifying chemical and moisture resistance of wood casework finish and finish of countertops where required.

1.4 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacture of wood casework with minimum 3 years experience.
- B. Source Limitations: Obtain casework, including countertops, sinks, service fittings and accessories, through one source from single manufacturer.
- C. Local Representative: Established resident in (Minneapolis/St. Paul) metropolitan area fully qualified in laboratory casework with authority to decide and act in connection with this project.
- D. Casework Assemblies: Manufacturers of casework, including components by others, shall assume complete responsibility of final assembled unit.
- E. Codes: Plumbing and electrical items provided under this section shall conform to National Plumbing Code, National Electrical Code, State Board of Health and other applicable codes and governing bodies.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site in manufacturer's protective covering.
- B. Store products in accordance with Section 015200.
- C. Do not deliver casework to site until destination space is ready to receive it. Do not deliver wood and plastic laminate work until building is sufficiently dry; relative humidity shall be no less than 50 percent.
- D. Coordinate size of access and route to place of installation. Handle finished surfaces with care to prevent damage.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install wood casework until building is enclosed, wet work and utility roughing-in are complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during remainder of construction period.

1.7 COORDINATION

- A. Coordinate casework with other trades, including Section 096500 for vinyl base and Mechanical and Electrical for requirements and as necessary to insure proper fitting, joining and clearances. Provide and obtain necessary dimensions, clearances, fixture and equipment lists and similar data. Exchange shop drawings where required.
- B. Make cutouts and holes for sinks, fittings, risers, ducts, and other features furnished into work of this section. Do not close up areas of casework until utilities have been installed. Verify electrical and mechanical characteristics.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Type and Manufacturer: Flush overlay prefinished oak wood casework by Kewaunee Scientific Equipment Corporation.
- B. Other Acceptable Manufacturers: Fisher Hamilton Scientific, Inc.

2.2 MATERIALS

- A. Wood Species: Red Oak.
- B. Hardwood: Suitable for intended use.
- C. Veneer Plywood: Plain sliced Red Oak. Edge with solid stock where exposed.
- D. Glass: FS DD-G-451; float or plate; 1/4 inch thick; FS DD-G-1403; tempered; 1/4 inch.
- E. Lead Shielding Panels: Sheet Lead, 99.9 percent pure virgin lead, 1/8 inch thick unless otherwise indicated.
- F. Markerboard Panel: Porcelain enamel fused to 28 gauge enameling steel with ground coat both sides, finish coat of fine grain matte in white color; surface shall be suitable for use and easy removal of markings. Firmly laminate steel to core with waterproof cement, by Claridge Products, Neal Slate, or Mirawal. Finish exposed trim surfaces with plastic laminate.
- G. Hardboard (Dividers): Commercial Standards CS-251 and FS LLL-B-00810.
 - 1. Tempered Hardboard 1/4 inch thick - smooth both sides.
- H. Plastic Laminate: NEMA LD3, 0.050 inch thick, black acid resistant type if required, color as selected.
- I. Modified Epoxy Resin: Cast resin and inert materials, formulated for chemical resistance; Durcon Company, Durcon 2A.
- J. Stainless Steel: ASTM A167, Type 304 commercial grade, No. 4 finish.
- K. Drying Rack Pegs: White polypropylene, replaceable.

2.3 HARDWARE

- A. Hinges: Heavy duty, five knuckle 2-1/2 inch institutional type hinge. Mill ground, hospital tip, tight pin feature with edges eased. Hinge shall be full wrap around type of tempered steel 0.093 inch thick. Each hinge with minimum 7 screws #8, 5/8 inch F.H.S.M. to assure positive door action and alignment.
 - 1. One pair per door to 48 inch height. 1-1/2 pair over 48 inches in height. Hinge to accommodate 13/16 inch thick laminated door, and allow 270 degree swing. Finish: Dull chrome.
- B. Pulls: Dull Chrome 4 inch projecting type.
- C. Sliding Door Hardware:
 - 1. Sliding Glass Doors 1/4 inch thick: Double track rolling door assembly.
 - 2. Sliding Glass Doors 3/4 inch thick Stile and Rail Doors: Top mounted track with dual roller hangers. Vertical adjustment for accurate alignment.
- D. Drawer Slides:
 - 1. Standard Drawers: Slide with positive in-stop, out-stop and out-keeper to maintain drawer in 80 percent open position. Captive nylon rollers, both front and rear. Minimum 100 lb., load rating. Provide adjuster cam to regulate body side sway, epoxy coated.

2. File Drawers: Full extension, 3 part progressive opening slide, minimum 100 lb. zinc plated or epoxy coated at manufacturer's option.
 3. File Drawer Followers: Knape and Vogt No. 476 follower and track assembly.
- E. Catches: 5 lb. magnetic catch for base and wall cabinets. Provide two 7 lb. pull at each tall cabinet door.
- F. Adjustable Shelf Supports: Provide locking device to prevent accidental shelf slide-off. Load rating minimum of 150 lbs. each support without failure. Cabinet interior sides flush, without shelf system permanent projection.
- G. Wardrobe Rod: 1-1/16 inch chrome steel rod, supported by chrome flange.
- H. Coat Hooks:
1. Single coat hooks - Ives 581 satin aluminum.
 2. Double coat hooks - Ives 405 satin aluminum.
- I. Molded Personal Pencil Drawer: Chemical resistant, high density polyethylene with in-stop and out-stop features. Compartmented drawer body and slides in Putty or Stone Grey.
- J. Tote Trays: High impact polyethylene with card holders.
1. Sizes: 10-1/2 inch wide by 3-1/2 inch high by 19 inches. 14-1/2 inch wide by 3-1/2 inch high by 19 inches.
 2. Tote trays shall glide on structural polyethylene continuous side rails, adjustable one inch on center.
- K. Locks: Disc tumbler lock keyed alike and master keyed. Dull chrome finish. Hinged doors and drawers National Lock No. 68-504.
1. Sliding doors 13/16 inch thick National Lock No. 68-057.
 2. 1/4 inch sliding panel door K & V #963.
- L. Wheel Casters: Swivel casters for standard mobile cabinets shall be plate type caster with ball bearing swivel. Size shall be 5 inch with 1-1/16 inch wide tread for carpet or hard cover floor. Wheel brakes on front 2 casters. Casters shall carry minimum 190 lb. load rating.
1. Casters for book trucks, carts and low-boy movable carts shall be 4 inch by 1-1/16 inch.
- M. Bumpers: Rubber bumpers where indicated, "locked-in" type with retaining collar.
- N. Shelf Standards and Rests: K & V extra heavy duty slotted standard #87 with #212 end rests (or 211-212). Satin chrome finish.
- O. Shelf Brackets: K & V #187 Satin chrome finish.

2.4 PLASTIC LAMINATE COUNTERTOPS

- A. Countertops and Working Surfaces: Comply with Premium Grade AWI Quality Standards. Lab grade and standard grade, post forming grade applied to core of particleboard as specified, 1-1/8 inch thick for total top thickness of 1-1/4 inch thick.
1. Eliminate joints where possible. Machine pressure bonded using waterproof adhesive, shear strength 200 pounds per square inch. High pressure plastic laminate, satin or textured finish minimum 0.50 inch thickness. Color as selected from manufacturer's stock standard patterns and solid colors.
 2. Heavy gauge, 1/16 inch neutral colored backing sheet for balanced construction.
- B. High Performance particle Board Core: Particle board shall be of 47 lb. density and balanced construction with moisture content not to exceed 8 percent. Particle board shall meet or exceed requirements for its type and classification under Commercial Standard CS-236, FS LLL-B-800A and ASTM D1037.
- C. Adhesive: Modified urea-formaldehyde resin for rigid glue line.
- D. Edging:

1. Provide self-edged surfaces to match countertop plastic laminate. Seal core surfaces not laminate faced with clear synthetic resin sealer.
2. Solid, high impact, purified, color-through, acid resistant, PVC edging machine-applied with hot melt adhesives automatically trimmed for uniform appearance.
3. Flat edge design for cabinet body in color-matched laminate or PVC.

2.5 MODIFIED EPOXY RESIN COUNTERTOPS AND SINKS

- A. Countertop and Working Surfaces: 1-1/4 inch thick. Maintain uniformity throughout full thickness, for level and true surface of non-glare black. Provide drip grooves on underside exposed edges; round edges to 1/4 inch radius at front top and at vertical corners; integral 3/4 inch backsplash coved at 3/4 inch radius.
 1. Physical Properties: Flexural strength (ASTM D790), compressive strength (ASTM D695), Rockwell-M hardness (ASTM D785).
- B. Sinks and tops of Sinks: Same material and thickness as tops. Groove drainboards to drain to sinks. Provide sink plug and drain fitting of Pyrex.
- C. Drying Racks: 1-1/4 inch thick with white pegs as specified. Fill and seal exposed backs to provide finish surface.

2.6 STAINLESS STEEL COUNTERTOPS

- A. Countertops and Working Surfaces: Reinforce tops, counters and similar surfaces with 16 gauge formed carbon steel channels, spaced as required to maintain flat surfaces under heavy loading. Comply with National Sanitary Foundation (NSF) Standards. Labels not required. Fabricate to eliminate field joints, field weld, grind and polish joints to match finish where required; 1-1/4 inch thick tops with integral backsplash 4 inches high. Sound deaden underside.
- B. Integral Sinks: Cove corners, one inch radius, pitch bottoms for drainage, partition between sinks, double wall with round top edge, sound deaden underside. Weld sinks to top. At sinks provide strainer and 4 inch by 1-1/2 inch O.D. tailpiece with connecting nut.
- C. Sound Deadening Material: 1/8 inch thick smooth spray coat, #EC-549 by 3M Company.
- D. Service Outlet Covers and Escutcheons: Stainless Steel.

2.7 FINISH

- A. Exposed Wood Casework: Manufacturer's standard finish. (Finish shall meet specified performance requirements.) Sheen of final coat: "Satin" (semi-gloss).

2.8 LABORATORY WOOD CASEWORK AND TOP FINISHES PERFORMANCE REQUIREMENTS

- A. Chemical Resistance Tests Definitions:
 1. Excellent: Test leaves no visible effect.
 2. Good: Test leaves no effect other than slight discoloration or change of gloss, or temporary slight softening of finish film with no loss of adhesion and no loss of film protection.
- B. Testing Procedure:
 1. Ten drops of each reagent applied to finish for specified time duration.
 2. Work Top Surfaces: Rinse surfaces and wipe dry for evaluation. Apply 20 drops of each reagent to finish for specified time duration covered with watch glass to retard evaporation. Wash surfaces with soap and water and wipe dry for evaluation.
 3. Reagents not included: Acceptable performance shall be equal or exceed performance of products of specified manufacturer.

2.9 MECHANICAL FIXTURES AND FITTINGS

- A. Fixtures and Fittings: Turn over water, gas and other plumbing fixtures and fittings to Division 23 for installation. Full and proper assembly and installation instructions shall be given by this section. In coordination with Division 23, this section shall check all parts and items to insure all items are complete and in good condition. Both trades shall agree on completeness and condition of items. Mark or tag all boxes for job location. Provide fixtures and fittings as standard with manufacturer for the item indicated.
 - 1. Gooseneck Water Faucets: Needle-nose hose ends, long needle type with 10 hose serrations. Faucets with hose ends shall have vacuum breaker similar to Chicago type.
- B. Omit traps and provide vacuum breakers as specified. In addition to standard supplied items at faucets with serrated hose connections, provide Chicago vacuum breakers (integral with faucets) and Dole type flow-control fittings. Provide inlet shanks, locknuts and washers to all outlets.
- C. Finish: Chrome plated units of laboratory grade red metal with copper content.

2.10 ELECTRICAL FIXTURES

- A. Fixtures: Turn over all fittings (receptacles, switches, plates, boxes), to Division 26 for installation. Full and proper assembly and installation instructions shall be given by this section. In coordination with Division 26, this section shall check parts and items to insure items are complete and in good condition. Both trades shall agree on completeness and condition of items. Mark or tag boxes for job location. Provide fixtures as standard with manufacturer for item indicated.
- B. Provide additional receptacles where indicated. Factory fabricate cutouts to receive fixtures.

2.11 FABRICATION

- A. Sub-Base: Separate and continuous (no cabinet body sides-to-floor), waterproof plywood with concealed fastening to cabinet bottom. Ladder-type construction, of front, back and intermediates, to form secure and level platform to which cabinets attach. Totally enclose base for dust and rodent proofing, with glue to cabinets and floor line for water and vermin seal. Vinyl base is specified in Section 096500 - Resilient Flooring.
- B. Base Units: Factory assembled integral units, flush overlap construction. Totally enclosed, including backs and ends. Return ends to walls, including at knee spaces. Provide scribe and filter strips to fit space and match remainder of work. Provide box frame unit across knee spaces with supports and framing required for sinks or other features. Where cabinets may be exposed to view on back side, back and curbs shall be neat and have finished appearance.
- C. Frames: Full horizontal solid hardwood frames, minimum 3/4 inch thick with top frame minimum 1-1/16 inch thick, mortised and tenoned into and glued into end panels under machine pressure. Provide horizontal frames between all drawers and between drawers and cupboards.
- D. End Panels: Solid end panels at units, exposed or non-exposed, minimum 3/4 inch thick plywood. Exposed ends of straight grained Oak plywood. Plywood shall have facing stile at exposed edges, minimum one inch by 3/4 inch.
 - 1. End panels shall be mortised and tenoned to receive hardwood frames. Back shall be housed into cabinet frames with glue and screws to insure rigidity and fully closed cabinet.
- E. Backs: Minimum 1/4 inch plywood. Fir may be used where behind solid doors and drawers. Provide Oak where exposed or at glass doors. At interiors of cupboards behind solid doors, face ply Grade A. Machine backs into solid end panels in manner to conceal end grain or back panel. Securely fasten to end panels and frames.
- F. Drawers: Minimum 3/4 inch thick faces, supported on frame, lapped four sides for dustproofing. Minimum 1/2 inch hardwood sides, dovetailed to fronts. Backs of 1/2 inch hardwood. Drawers removable with stop.

1. Provide drawers with drawer keels of Oak or Maple, one at drawers up to 28 inches wide; 2 at drawers over 28 inches wide. Non-binding type keels, minimum one inch wide. Chamfer keel edges on 30 degree angle to fit concave track in lower member of keel.
 2. Groove drawers horizontally at four inside sides, for future partitioning. Drawer bottoms 1/4 inch plywood or tempered hardboard, let into sides, front and back.
- G. Dust and Lock Panels: Provide full panel wherever drawer is over cupboard and between locked drawers.
- H. Doors: Minimum 3/4 inch thick, solid doors with edge band sides, concealed by veneer faces. Overlap four sides. Capable of supporting 150 lbs. load, one foot from hinge side, through full door swing. Cores of solid built-up blocks. Novoply chipboard cores will be acceptable if edge banded.
- I. Hinged and Sliding Doors. Drawer fronts and hinged doors to overlay cabinet body. Maintain maximum 1/8 inch reveal between pairs of doors, between door and drawer front, or between multiple drawer fronts within cabinet.
1. Stile and Rail Doors: 3/4 inch thick wood door, stiles 3-3/16 inch wide and center rail 2-1/2 inch wide, with 1/4 inch plate glass, hinged or sliding. Exposed edges wood trimmed and glazed with extruded vinyl glazing bead.
 2. Sliding Glass Doors: 1/4 inch thick plate glass with ground and polished edges. Fitted with etched and anodized aluminum shoes and nylon rollers, and dustproofing strips at front facing stiles and between doors. Top hung roller bearing assemblies and bottom guides.
- J. Vertical and Horizontal Dividers: Tempered hardboard 1/4 inch thick, smooth both faces. Secured in cabinet with molded plastic clips.
- K. Shelves: Shelf in all cupboards, behind glass doors provide solid stock Oak or Oak plywood with shelves having minimum one inch wide hardwood leading edge strip.
1. Thickness: 3/4 inch standard shelving to 36 inches wide. One inch shelving 36 inches wide and over.
- L. Upper Storage Cases: Factory assembled, integral units. Totally enclosed, including backs and ends, same materials as base cabinets. Tops, bottoms and backs machined into end panels, glued and with screw and corner block fastening as required to provide rigid and stable units.
- M. Provide continuous tops for counter type cabinets fixed in line.
1. Fabricate countertops for scribe fit.
- N. Joints: Cabinet parts shall be accurately machined with mortise and tenon for quality grade joinery construction. Glue and screw joints for maximum stability and construction.
- O. Cases shall be square, plumb and true.
- P. Provide removable back panels and closure panels for plumbing access where indicated.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify adequacy of backing and support framing.
- B. Obtain dimensions affecting work of this Section from site. Verify dimensions of casework locations prior to fabrication.
- C. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

- A. Use anchoring devices for materials encountered and usage expected.
- B. Install items in accordance with manufacturer's instructions.

- C. Set casework items plumb, square and true, securely anchored to building structure.
- D. Base Cabinets: Adjust top rails and subtops within 1/16 inch on single plane. Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inch on center. Fasten adjacent cabinets together with joints flush, tight and uniform. Align similar adjoining doors and drawers to tolerance of 1/16 inch.
 - 1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inch on center and at sides of cabinets with not less than 2 fasteners per side.
- E. Wall Cabinets: Adjust fronts and bottoms within 1/16 inch of single plane. Fasten to hanging strips, partition framing, blocking, or reinforcement in partitions. Fasten each cabinet through back, near top, at not more than 24 inch on center. Align similar adjoining doors to tolerance of 1/16 inch.
- F. Scribe to abutting surfaces; set level and rigid, and align adjoining pieces of casework. Apply matching filler pieces where casework abuts walls, columns, and is to be closed off.
- G. Sequence installation and erection to ensure mechanical and electrical connections are achieved in orderly and expeditious manner.
- H. Cut, fit, and patch where necessary. Coordinate work with others.

3.3 ADJUSTING AND CLEANING

- A. Adjust doors, drawers, hardware, fixtures, and other moving or operating parts to function smoothly and correctly.
- B. Clean casework, counters, shelves, glass, legs, hardware, fittings, and fixtures.

END OF SECTION

SECTION 123553.16
PLASTIC LAMINATE LABORATORY CASEWORK AND FURNISHINGS

PART 1 GENERAL

1.1 SUMMARY

A. Related Documents

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

B. Summary of Work Included

1. Furnishing of materials, products, accessories, tools, equipment, services, scaffolding, ladders, transportation, supervision, labor, product protection, and other items that may not be specifically mentioned, but are necessary for the fabrication and installation of plastic laminate laboratory casework.
2. Furnish and install plastic laminate laboratory casework including, but not limited to, counter tops, support framing, slotted studs, filler panels, scribes, knee space panels, accessories, utility space framing, utility space closure panels between base cabinets and at exposed ends of utility spaces, laboratory sinks, cup sinks, strainers, overflows and sink outlets with integral or separate tail pieces and miscellaneous items of equipment as listed in these specifications and as shown on drawings, including delivery to the building, unpacking, setting in place, leveling and scribing to walls and floors as required.
3. Furnish and deliver packed in boxes for receipt, handling and installation by others; electrical service fixtures, task lights including fluorescent bulbs, electrical receptacles and switches listed in these specifications and as shown on drawings as part of the laboratory casework. The above-defined items are to be supplied, not attached, and loose in boxes, properly marked for tailgate delivery.
4. Furnish and set in place for installation by other trades; service fittings where part of the laboratory casework, listed in the specifications or shown on drawings. Tailpieces shall be furnished less couplings required to connect to the trap or drain piping system. Install service fittings "finger tight".
5. Furnish and mount plumbing and electrical fixtures on fume hood superstructure.
6. Casework System: Laboratory casework components and assemblies shall meet local seismic restraint requirements.

C. Related Work By Other Specification Sections

1. Furnishing, installation and connection of "Service Lines" within and/or attached to equipment, slotted studs, partitions, service tunnels or service turrets, through, under or along backs of working surfaces as required for "Service Fixtures."
2. Final installation, tightening and connecting "Service Fixtures" furnished by laboratory casework manufacturer including the pulling of wire and connecting of electrical fixtures in service lines.
3. Connecting separate laboratory sinks, cup sinks or drains, overflows, sink outlets and tail-pieces furnished by the laboratory casework manufacturer.
4. Furnishing, installing and connecting vents and drain lines.

5. Furnishing, installing, setting and connecting special electrical and plumbing fixtures and piping to meet local codes, even though not specifically called for in specifications and shown on drawings.
6. Furnishing, installing and connecting of ducts from fume hoods to blowers and from blowers to atmosphere.
7. Furnishing, handling and installing fans with motors (blowers).
8. Furnishing and installation of framing or reinforcements for wall, floors and ceilings to adequately support laboratory equipment and brick, plaster, metal or wood grounds required for proper anchoring of the equipment.
9. Furnishing and installation of pipe hangers.
10. Furnishing and installation of resilient base on walls and fixed laboratory casework after laboratory casework installation in complete.
11. Furnishing in-wall exhaust duct and connection to vented cabinets.
12. Related Sections include the following:
 - a. Division 1 Section "LEED Requirements" for additional LEED requirements.
 - b. Division 6 Section "Rough Carpentry" for wood blocking for anchoring laboratory casework.
 - c. Division 9 Section "Gypsum Plaster" for reinforcements in metal-framed plaster partitions for anchoring laboratory casework.
 - d. Division 6 Section "Interior Architectural Woodwork".
 - e. Division 9 Section "Gypsum Board Assemblies" for reinforcements in metal-framed gypsum board partitions for anchoring laboratory casework.
 - f. Delete first subparagraph below if base for laboratory casework is in this Section.
 - g. Division 9 Section "Resilient Wall Base and Accessories" for resilient base applied to plastic-laminate laboratory casework.
 - h. Division 11 Section "Laboratory Fume Hoods".
 - i. Divisions 15 and 16 Sections for installing service fittings specified in this Section.

D. Definitions

1. "Laboratory Casework Contractor" is defined as the manufacturer and/or manufacturer's representative furnishing and installing the laboratory casework, equipment, and accessories listed under these specifications, laboratory equipment schedule and/or shown on drawings.
2. "Service Fixtures" are defined as gas, air, and vacuum cocks, hot, cold, reagent grade water faucets, remote control valves, electrical receptacles with necessary flush mounting boxes, conduits or pedestals and plates, fluorescent and/or incandescent light fixtures, light switches and/or motor switches for hoods and other items which serve as a functional part of the equipment.
3. "Service Lines" are defined as gas, air, vacuum, hot, cold, reagent grade and reference grade water piping, drain lines, fittings and shut off valves necessary to carry respective services from building roughing-in floors or walls through equipment to "service fixture".
4. "Service Lines" also include conduit, junction boxes, conduit fitting, wire disconnect switches and fuse or circuit breakers necessary to carry electrical services from building roughing-in outlets in floors or walls through equipment to "service fixtures."
5. "Standards" are wall mounted, twin-tracked shelf supports.
6. "Slotted Studs" are double-faced, twin-tracked studs comprising the frame spanning between the utility chase and the building wall or workstation at peninsula bench assemblies.

7. Exposed Portions of Casework: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches (1200 mm) above floor, and visible surfaces in open cabinets or behind glass doors. Sides, fronts, backs and tops of movable casework are defined as exposed.
8. Semi-exposed Portions of Casework: Surfaces behind opaque doors, such as interiors of cabinets, shelves, dividers, interiors and sides of drawers, and interior faces of doors. Tops of cases 78 inches (1980 mm) or more above floor are defined as semi-exposed.
9. Concealed portions of fixed casework include sleepers, web frames, dust panels, and ends and backs that are placed directly against walls or other cabinets and other surfaces not usually visible after installation.

1.2 REFERE NCES

- A. Scientific Equipment & Furniture Association (SEFA)
 1. SEFA 1 2002 Laboratory Fume Hoods
 2. SEFA 2.3 2002 Scientific Laboratory Furniture And Equipment
 3. SEFA 3 1996 Work surfaces
 4. SEFA 7 1996 Laboratory and Hospital Fixtures
 5. SEFA 8 1999 Laboratory Furniture-Casework-Shelving and Tables – Recommended Practices.
- B. American Society for Testing and Materials (ASTM)
 1. A240-Heat Resistant Chromium and Chromium – Nickel Stainless Steel Plate, Sheet, and Strip for pressure Vessels
 2. A312-Seamless and Welded Austenitic Stainless Steel Pipe
 3. D260- Boiled Linseed Oil
 4. D570-Water Adsorption of Plastics
 5. D695-Compressive Properties of Rigid Plastics
 6. D790-Fluctural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials.
 7. E-84 Test Method for Surface Burning Characteristics of Building Materials.
 8. A554 Standard Specification for Welded Stainless Steel Mechanical Tubing
 9. A513 Standard Specification for Electric Resistance Caron and Alloy Steel Mechanical Tubing
- C. Builders Hardware Manufacturers Association (BHMA).
- D. National Electrical Manufacturers Association (NEMA)
- E. American National Standards Institute (ANSI) A208.1 Wood Products
- F. American National Standards Institute (ANSI) A135.4 Basic Hardwood.
- G. American National Standards Institute (ANSI) APVA HP-1-2000 American National Standard for Hardwood and Decorative Plywood.
- H. American Plywood Association (APA) Engineered Wood Association.
- I. National Particleboard Association (NPA) 8-Voluntary Standard for Formaldehyde Emission from Particleboard.
- J. United States Department of Commerce, Product Standard (PS) 1-Construction and Industrial Plywood
- K. United States Department of Commerce, Product Standard (PS) 51-Hardwood and Decorative Plywood.
- L. National Fire Protection Association (NFPA) 30 Flammable Liquid Storage
- M. National Fire Protection Association (NFPA) 70 Electrical Components, Devices and Accessories.
- N. Woodwork Institute of California (WIC) Manual of Millwork

1.3 SUBMITTALS

- A. Refer to submittal section of the General and Supplementary Specifications in Division 1 for requirements and procedures. Fabrication or purchase of any items prior to approval will be at the manufacturer's risk.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For plastic-laminate laboratory casework. Include plans, elevations, sections, details, and attachments to other work.
1. Indicate locations of blocking and reinforcements required for installing laboratory casework.
 2. Indicate locations and types of service fittings, together with associated service supply connection required.
 3. Include details of utility spaces showing supports for conduits and piping.
 4. Include details of exposed conduits, if required, for service fittings.
 5. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
 6. Include coordinated dimensions for laboratory equipment specified in other Sections.
- D. Shop Drawings. Fabrication or purchase of any equipment prior to approval will be at the manufacturer's own risk. The laboratory casework manufacturer shall furnish shop drawings showing enclosures, cabinets, hardware, and service banks complete with numbers and names of items and details including construction kinds and gages of materials for hood, cabinets, benches and other items necessary to complete the work. In addition, it is the responsibility of the casework manufacturer to flag any deviations in dimension, material, detail, etc. that is not exactly the same as shown on the contract documents. Those deviations not flagged will be considered "not reviewed", even if missed during the approval process and will have to be changed. Provide number of copies of drawings and data sheets in accordance with Division 1 requirements.
- E. Non-Structural Lateral Force Design: Submit detailed seismic anchorage and attachment drawings and calculations provided by a California-licensed Structural Engineer in compliance with the 2007 California Building Code. The 400 pound exemption sometimes used for seismic anchorage shall not apply. The submittal shall include:
1. Dimensions and location of the center of gravity of the component.
 2. Weight assumed in the calculations including contents.
 3. Specification of anchorage to concrete in detail, including inspection and testing requirements, if any (inspection and testing to be furnished under this section, if required).
 4. Reaction loads to the supporting structure or other component.
 5. If a component other than the structure is used for seismic support, the submittal shall show the adequacy of the load path to the structure or otherwise demonstrate compliance with limitations in the contract documents.
- The submittal will be reviewed by the design professional responsible for this section of the specifications to confirm that it is responsive to project specific context and criteria. The adequacy of the primary structure to resist the reaction loads imparted on the primary structure by shall be reviewed and approved by the project Structural Engineer.
- F. Samples for Initial Selection: For plastic-laminate cabinets, epoxy sinks, and epoxy countertops.
- G. Samples for Verification: For each type of finish, including countertop material, in manufacturer's standard sizes.
- H. Samples for Verification: Unless otherwise directed, approved Sample units will be retained by the Owner's Representative
1. 6-inch- (150-mm-) square Samples for each type of countertop material.
 2. One Sample each of hinge and pull
 3. One of each service fitting specified, complete with accessories and specified finish.
 4. Countertop material (one of each specified)" 12" x 12" x 1" (300mm x 300mm x 25mm) thick, showing top, front edge and backsplash construction.

5. One (1) 24" (600mm) long standard and one (1) end bracket, all with specified finish.
6. Adhesives and sealants.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified for testing indicated, as documented according to ASTM E 548.
- B. Installer Qualifications: An authorized representative of the casework manufacturer for installation and maintenance of units required for this Project.
- C. Source Limitations: Obtain laboratory casework, including countertops, sinks, service fittings, and accessories, through one source from a single manufacturer.
 1. Obtain through same source from same manufacturer as fume hoods specified in Division 11 Section "Laboratory Fume Hoods."
- D. Product Standard: Comply with SEFA 8, "Laboratory Furniture--Casework, Shelving and Tables--Recommended Practices."
- E. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements of NFPA 30 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 1. Cabinets that are not listed and labeled but are constructed according to NFPA 30, Paragraph 4-3.3(c) may be used if acceptable to authorities having jurisdiction.
- F. 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 EXEMPTIONS TO DRAWINGS AND SPECIFICATION

- A. All exceptions shall be subject to written approval prior to receipt of bid. If no written communication is received prior to receipt of bid and approval indicated in an addendum, it is assumed that bidder will be in total compliance with specifications and will be held responsible for default or delay, regardless of any statement to the contrary in their written proposal.
- B. Requests for a substitution must be made directly to the Owner's Representative's office for consideration no later than fifteen (15) working days prior to bid receipt date.
- C. Requests for a substitution following the bid opening will be rejected.
- D. Substitutions approved prior to bid date will be handled as an addendum and be sent to all bidders.

1.6 WARRANTY

- A. Furnish a written warranty that Work performed under this Section to be and remain free from defects as to materials and workmanship for a period of one (1) year from date of acceptance. Defects in materials and workmanship that may develop within this time are to be replaced without cost or expense to the Owner. Defects include, but are not limited to:
 1. Ruptured, cracked, or stained coating
 2. Discoloration or lack of finish integrity
 3. Cracking or peeling of finish
 4. De-lamination of components or edge banding
 5. Slippage, shift, or failure of attachment to wall, floor, or ceiling
 6. Weld or structural failure (visible weld marks)
 7. Warping or unloaded deflection of components
 8. Failure of hardware

1.7 TESTING

- A. The laboratory casework manufacturer shall be required to include in their initial submittals, certified test reports indicating compliance of their laboratory casework finish and work top materials with requirements specified for chemical and physical resistance; and confirmation of load performance for movable tables. The material test reports shall be performed by an independent testing agency qualified for testing indicated, as documented according to ASTM E548.

1.8 FIELD MEASUREMENTS

- A. It is the laboratory casework manufacturer's responsibility to verify field measurements and that equipment will fit through entryways, corridors and door openings enabling a smooth flow of equipment to its proper location in the building. Wall-to-wall counter tops are to be installed with a maximum ¼" (6.35mm) gap.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.
- B. Deliver casework only after painting, utility rough-ins and similar operations that could damage, soil or deteriorate casework have been completed in installation areas. If casework must be stored in other than installation areas, store only in areas where environmental conditions meet requirements specified in "Project Conditions" Article of this specification section.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install plastic-laminate laboratory casework until building is enclosed, wet work and utility roughing-in are complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where casework is indicated to fit to other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating the casework without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.11 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for support of plastic-laminate laboratory casework.
- B. Coordinate installation of plastic-laminate laboratory casework with installation of fume hoods and other laboratory equipment including rough-in locations and requirements.

1.12 EXTRA MATERIALS

- A. Furnish complete touch-up kit for each type and finish of the casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damages casework finish.
- B. Furnish extra materials described in Part 3 that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Plastic-Laminate-Faced Casework:

- a. Caseworx (Redlands, CA)
 - b. K&Z Cabinet Company, Inc. (Ontario, CA)
 - c. Therm oFisher Scientific (formally Fisher Hamilton) (Two Rivers, WI)
2. Chemical-Resistant Plastic Laminates:
- a. Arborite; Division of Premark Canada Inc.
 - b. Formica Corporation.
 - c. International Paper; Decorative Products Division.
 - d. Panolam Industries International Incorporated; Pionite Decorative Surfaces.
 - e. Wilsonart International.
3. Epoxy Countertops, Sinks:
- a. Durcon Company, Inc. (The).
 - b. Epoxyn Products.
 - c. Laboratory Tops, Inc.
- B. Other Manufacturers: Subject to meeting or exceeding Basis of Design and specified requirements.
- C. Color/finish to be selected by Architect.

2.2 CA BINET MATERIALS

- A. General:
- 1. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.
 - 2. Edge-banding for Plastic Laminate: Rigid PVC T-molding, through color with satin finish, 3 mm thick.
 - 3. Colors: As selected by Architect from manufacturer's full range.
- B. Exposed Materials:
- 1. Plastic Laminate: Type VGS.
 - a. Colors: As selected by Architect from manufacturer's full range.
- C. Semi-exposed Materials:
- 1. Plastic Laminate: Type VGS
 - 2. Colors: As selected by Architect from manufacturer's full range.
- D. Concealed Materials:
- 1. Solid Wood: Any hardwood or softwood species, with no defects affecting strength or utility.
 - 2. Plywood: Hardwood plywood.
 - 3. Plastic Laminate: Type BKL.
 - 4. Particle board.
 - 5. Medium density fiberboard.
 - 6. Hardboard: AHA A135.4, Class 1 tempered.
- E. Glass for Glazed Doors: Clear laminated glass complying with ASTM C 1172, Kind LT, Condition A, Type I, Class I, Quality q3; with 2 lites not less than 3.0 mm thick and with clear, polyvinyl butyral interlayer.

2.3 CA BINET DESIGN

- A. Casework shall be fabricated as sectional units, ready for placement in the laboratory as a complete integral rigid unit permitting relocation at any subsequent time. Equivalent to WIC Section 14 Laboratory Grade, Type 1. Style of cabinets is Flush Overlay. Component parts of the unit shall be manufactured ensuring uniformity, interchangeability and accurate alignment. No staples will be permitted as fasteners on any cabinet components. All base cabinets to have integral enclosed bases.
- B. Base cabinets must be capable of supporting an equipment load of at least 500lb. per running foot (304.8mm) above and beyond the weight of the assembly including the counter top when tested in accordance with the test procedures as outlined in SEFA 8 Section 4

- C. Where noted as such, provide wall-mounted casework that matches all other laboratory casework in design and material. The assembly must be capable of supporting an equipment load of at least 150 lb. (68.04kg) per running foot (304.8mm) above and beyond the weight of the assembly when tested in accordance with the test procedures as outlined in SEFA 8 Section 9.

2.4 CA BINET FABRICATION

- A. Construction: Provide plastic-laminate-faced laboratory casework of the following minimum construction:
1. Bottoms and Ends of Cabinets; Bottoms, ends and tops of Wall Cabinets and Tall Cabinets: 3/4-inch- (19-mm-) thick plywood, plastic-laminate faced
 2. Backs of Stationary Cabinets: 1/2-inch- (12.7-mm-) thick particleboard, plastic-laminate faced on exposed surfaces, melamine faced on semi-exposed surfaces, dadoed into sides, bottoms and tops where not exposed. Removable backs shall be removable from inside the cabinet with a minimal use of tools. Provide 1 inch x 1 inch cleats, top, bottom and sides, at the rear corners of the cabinet to fasten the removable panel.
 3. Drawer Fronts: 3/4-inch- (19-mm-) thick particleboard, plastic-laminate faced on both sides.
 4. Drawer Sides and Backs: 1/2-inch- (12.7-mm-) thick plywood, with glued dovetail or multiple-dowel joints.
 5. Drawer Bottoms: 1/4-inch- (6.4-mm-) thick melamine-faced particleboard glued and dadoed into front, back, and sides of drawers. Use 1/2-inch- (12.7-mm-) thick material for drawers more than 24 inches (600 mm) in width.
 6. Doors 48 Inches (1200 mm) or Less in Height: 3/4 inch (19 mm) thick, with particleboard or medium-density fiberboard cores, solid wood stiles and rails, and plastic-laminate faced on both sides.
 7. Stiles and Rails of Glazed Doors: 3/4-inch- (19-mm-) thick particleboard, plastic-laminate faced on both sides.
 8. Plastic-Laminate Shelves: Plastic-laminate sheet complying with NEMA LD 3, shop bonded with waterproof adhesive to both sides. Use 3/4 inch hardwood plywood for core if 30 inch long or less; use 1 inch thick hardwood plywood for shelves longer than 30 inches with 3mm Rigid PVC edgebanding on front of fixed shelves within cabinets and all four edges of adjustable shelves. Sand surfaces to which plastic laminate is to be bonded. Top and bottom surfaces shall be laminated with matching laminate.
 9. Leg Shoes: Vinyl or rubber, black, open-bottom type.
- B. Utility-Space Framing: Laboratory casework manufacturer's standard steel framing units consisting of 2 steel slotted channels complying with MFMA-2, not less than 1-5/8 inches (41 mm) square by 0.0966 inch (2.5 mm) thick, and connected together at top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch (32-by-6-mm) steel flat bars. Framing units may be made by welding specified channel material into rectangular frames instead of using U-shaped brackets.
- C. Filler Strips and Utility-Space Closure Panels: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinet fronts.

2.5 C ABINET HARDWARE

- A. General: Provide laboratory casework manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.
- B. Hinges on base and wall cabinets shall be exposed axle, zinc die cast and satin chrome plated finish complying with BHMA A156.9, Grade 1 with antifriction bearings and rounded tips similar to units as manufactured by Hafele Aximate #344.52.101, Grass #950 or Hettich #4000-180T22-11M. Hinge shall be capable of supporting a 150 lb. dynamic load, 100 lbs on each side of the door located 12" from the hinge. Provide (2) hinges for 36" high doors, (3) for 48" high doors and (4) for 84" high doors.

- C. Pulls: Solid aluminum; Door and drawer pulls shall be 4" (101.6mm) wire type, satin chrome plated finish, fastened from back with two screws. Drawer pulls shall be installed horizontally, door pulls shall be installed vertically. Wall cabinet and floor storage cabinet pulls should be located for reaching convenience and ADA accessibility guidelines. Provide 2 pulls for drawers more than 24 inches (600 mm) in width.
- D. Door Catches: Catches shall be provided on hinged doors and shall be nylon-roller spring catch or dual, self-aligning, permanent magnet catch. Provide 2 catches on doors more than 48 inches (1200 mm) in height. Tall cases shall have latching devices located on the structurally fixed center shelf. Double doors without locks shall have a catch on each door. The left hand door shall have a positive catch and the right hand door shall have a roller type catch. Where locks are used, catches and strike plates shall be used on left hand doors of double door cases and shall be steel, cadmium plated.
- E. Drawer Slides:
 1. Drawer slides shall be self-closing, nylon tired, ball bearing, full extension zinc plated assembly that will allow the drawer body to be completely exposed and physically accessible, complying with BHMA A156.9, Type B05091. Drawer slides shall have an integral stop mechanism to avoid inadvertent removal. Assembly shall be typically rated for 100 lb. at full extension, dynamic load. Slides shall be as manufactured by Precision Slide, Accuride or Waterloo.
 2. Drawer slides for file or bin drawers shall be nylon tired, ball bearing, full extension zinc plated assembly that will allow the drawer body to be completely exposed and physically accessible, complying with BHMA A156.9, Type B05091. Drawer slides shall have an integral stop mechanism to avoid inadvertent removal. Assembly shall be typically rated for 150 lb. at full extension, dynamic load. Slides shall be as manufactured by Precision Slide, Accuride or Waterloo.
- F. Rollers and Sheaves: Rollers and sheaves shall be cadmium plated hardened steel or nylon, specifically designed for their application. Sliding door sheaves shall have a special contour for engagement with the one-piece double "V" stainless steel tracks. The positive ball bearing sliding door retainers shall be adjustable for removal of the doors when required.
- G. Leg Shoes: Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling device. Leg shoes shall be pliable 2.5" (35mm) high, coved to the floor at the bottom and shall be cemented tightly at the floor with clear silicone sealant.
- H. Toe Space Filler: At gap created between the cabinet or ledge static panel and the floor due to leveling conditions, mechanically fasten (flat head screw) a 4" (101.6mm) wide 18 gage (1.21mm) galvanized steel plate to the cabinet behind the base molding to support its application. Provide continuous clear silicone sealant at intersection of floor/wall and steel plate.
- I. Shelf Adjustment. Adjustable shelf support clips inside wall, floor and base cabinets shall be designed for adjusting shelves on 2" (50mm) centers and shall be nylon complying with BHMA A156.9, Type B04013. Clip shall be configured to clamp top and bottom of shelf to avoid movement. Clip may have one or two pins. In addition to shelf clips required for initial assembly, six (6) dozen additional clips to be provided to the owner. Clips shall be Hafele #282.47.402 clear (provides the "clamping" to avoid shelf movement).
- J. Locks: Locks to be furnished where noted on the Drawings. Drawer and door locks shall be brass, five-pin tumbler type, complying with BHMA A156.11, Type EO7281 having para-centric keys. The exposed face shall be chromium plated with satin finish. Locks shall be mounted in special housing so designed as to prevent removal when in locked position. The locks and lock housings shall be fully concealed within the drawer heads and doors. The lock tongues shall engage the rails or stiles when in locked position. Install theft panels above each drawer or cupboard segment in order to isolate locked section. Locks shall be separately keyed (including cabinets with multiple locks and cabinets in the same room) and two (2) keys shall be furnished with each lock. Supply two (2) master keys for all locks.

- K. Standards: Surface mounted adjustable shelves, shall be mounted to twin-tracked standards. Standards shall be coated with an epoxy powder coating complying with BHMA A156.9 Types B04102 with a nominal cross section of 1-1/2" x 1/2" (38.1mm x 12.7mm). Acceptable manufacturers shall be Reeve, Fixture Hardware Manufacturing Corporation, and Knape and Vogt. Standards and slotted studs shall have a fully compatible slot pattern. Fasten standards to concrete masonry walls or properly blocked steel studded walls with appropriate flat head screws. Adjustable shelves, wall cabinets and pegboards will be furnished with integral mounting brackets or clips.
- L. Slotted Studs: Adjustable shelves, wall cabinets and peg boards mounted above peninsula or island benches shall be mounted to a welded double-sided, twin tracked stud assembly. Assembly shall be fabricated of 14 gage, fully welded, steel tube with slots laser cut into uprights and be coated with an epoxy powder coat. Acceptable manufacturers shall be Reeve, Fixture Hardware Manufacturing Corporation, and Knape and Vogt. Slotted studs and standards shall have a fully compatible slot pattern. Adjustable shelves, wall cabinets and pegboards shall be furnished with integral mounting brackets or clips to meet design load.
- M. File Drawers. File drawers shall be furnished with Pendaflex metal inserts to hold files in a front-to-back configuration. File drawer shall be notched appropriately to accept metal inserts.
- N. Glazing in doors shall be installed on a foam cushion with the glazing tape installed on sides trimmed below the level of the frame and glazing stops. Glazing stops shall be of the same material and finish as the cabinet door.
- O. Levelers are 3/8" – 16 NC x 3.5" long, model # 23015T56 as manufactured by McMaster-Carr Supply Company, New Brunswick, NJ.

2.6 COUNTERTOPS, SHELVES, AND SINKS

- A. Countertops, General: Provide units with smooth surfaces in uniform plane free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch (25 mm), with continuous drip groove on underside 1/2 inch (13 mm) from edge.
- B. Adjustable shelves shall be 15" (375mm) deep, unless otherwise noted on the Drawings.
- C. Adjustable shelves shall be mounted to surface type steel standards (wall condition) or slotted studs (above peninsula benches). Adjustable shelves shall be supported by steel shelf brackets not to exceed 48 inches on center. Brackets shall be cold rolled steel with epoxy powder coated finish, complying with BHMA A156.9, Types B04102 and B04112. Shelves shall be fastened to brackets with two stainless steel screws per bracket.
- D. Adjustable shelves mounted on slotted studs shall be supplied with edge-banding on all four sides with a continuous 2" (50.8mm) high band to create a 1" (25.4mm) high curb at the rear of the shelf. The curb along the back shall be of similar material as the shelf.
- E. Exterior adjustable shelves, those not in cabinets, shall be equipped with a 1/4 inch (6.35mm) diameter, 2 inch (50.8mm) high anodized aluminum rail at the front of the shelf. Rail lengths shall not exceed 36" (914mm) in nominal length (provide two 24" (609.6mm) long nominal rails for 48' (1219mm) shelves). Rails shall be fastened to the shelf in a similar manner as wire pulls are fastened to drawers and doors. Stainless steel screws to be accessible from underside of shelf. Press fit rails are acceptable.
- F. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Owner's Representative.
 - 1. Outlets: Provide with acid-resistant strainers and tailpieces, NPS 1-1/2 (DN 40), unless otherwise indicated.
 - 2. Overflows: For each sink except cup sinks, provide overflow of standard beehive or open-top design with separate acid-resistant strainer. Height 2 inches (50 mm) less than sink depth. Provide in same material as strainer.
- G. Plastic-Laminate Shelves
 - 1. Plastic-Laminate Type for Flat Countertops: HGS.

2. Plastic-Laminate Type for Formed Countertops: HGP.
 3. Plastic-Laminate Type for Shelves: HGL.
 4. Plastic-Laminate Type for Backing: BKL.
 5. Chemical-Resistant Plastic Laminate: Provide product for shelves that complies with grade specified above and has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:
 - a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), amyl acetate, benzene, butyl alcohol, carbon tetrachloride, chloroform, dimethyl formamide, dioxane, ethyl acetate, ethyl alcohol, ethyl ether, formaldehyde (37 percent), gasoline, gentian violet, hydrogen peroxide (3 percent), methyl alcohol, methyl ethyl ketone, methylene chloride, mono chlorobenzene, naphthalene, toluene, trichloroethylene, xylene, and zinc chloride (saturated).
 - b. Slight Effect: Cresol, methyl red, phenol (90 percent), sodium hydroxide (20 percent), sodium sulfide (15 percent), and tincture of Iodine.
 - c. Moderate Effect: Hydrochloric acid (37 percent), nitric acid (30 percent), phosphoric acid (75 percent), silver nitrate (saturated), and sulfuric acid (77 percent).
 6. Shelf Core: Hardwood faced plywood, medium-density-overlaid plywood, exterior glue.
 7. Colors, Textures, and Patterns: As selected by Owner's Representative from plastic-laminate manufacturer's full range.
- H. Epoxy Countertops and Sinks: Factory molded of modified epoxy-resin formulation with smooth, non-specular finish.
1. Physical Properties:
 - a. Flexural Strength: Not less than 10,000 psi (70 MPa).
 - b. Modulus of Elasticity: Not less than 2,000,000 psi (1400 MPa).
 - c. Hardness (Rockwell M): Not less than 100.
 - d. Water Absorption (24 Hours): Not more than 0.02 percent.
 - e. Heat Distortion Point: Not less than 260 deg F (127 deg C).
 2. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:
 - a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
 - b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).
 3. Color: As selected by Owner's Representative from manufacturer's full range.
 4. Countertop Fabrication: Fabricate with factory cutouts for sinks and with butt joints assembled with epoxy adhesive and pre-fitted, concealed metal splines.
 - a. Countertop Configuration: Flat, 1 inch (25 mm) thick, with beveled edge and corners, and with drip groove and integral coved backsplash.
 5. Countertop Construction: Uniform throughout full thickness.
 6. Sink Fabrication: Molded in 1 piece with smooth surfaces, coved corners, and bottom sloped to outlet; 1/2-inch (13-mm) minimum thickness.
 - a. Provide with polypropylene strainers and tailpieces.
 - b. Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.
 7. Cup Sinks: Epoxy, 5 inch x 14 (125 mm x 350 mm). Mount cup sink on the surface of the work surface in order to avoid discharge of chemicals in waste stream.
 8. Sink Supports: Epoxy sinks mounted in epoxy resin work surfaces shall be supported on steel channels under the sink and compressed by screw type rods to insure a tight fit to the underside of the work surface with a waterproof compound. Drop-in style epoxy sinks will also be acceptable.
 9. Overflow: Sinks shall be equipped with an overflow that is connected directly to the tailpiece. Overflow shall consist of an outlet located 2 inches (50.8mm) below the sink rim and 1/2 inch (25mm) diameter minimum flexible tygon or polypropylene tubing to connect overflow to tailpiece which shall be modified to accept tubing.
 10. Outlets and Tailpieces: Provide each sink with an outlet and tailpiece.
 11. Traps: Furnished under Division 22.

2.7 MECHANICAL SERVICE FITTINGS

- A. Manufacturers. Service fittings shall be manufactured by:
 - 1. Water Saver Corporation,
 - 2. Far Laboratories,
 - 3. Broen Corporation.
 - 4. Chicago Faucets.
- B. Mechanical service fixtures shall comply with SEFA 7, "Laboratory and Hospital Fixtures-Recommended Practices. Fixtures for liquids and gaseous mixtures shall have lettered and colored indexes for each service. Handles shall be provided with color tabs indentifying utility. Fixtures for gas, air and vacuum shall be needle valve, large type. Water fixtures shall be compression type. Drain fittings shall be polypropylene unless otherwise noted. Fixtures that serve special gases (N2, O2,NO2,etc.) and instrument air shall be lubricated, cleaned, capped protected, and delivered certified for "Oxygen" service.
 - 1. Provide fittings complete with washers, locknuts, nipples and other installation accessories necessary for final connection. Include the deck flanges, escutcheons, handle extension rods and similar items.
- C. Materials: Plumbing fixtures, except for drain fixtures and fittings, shall be a forged red-brass composition containing at least 85% copper with washers and seats, of maximum wear resistant materials for the specific use. Reagent grade water fixture to be brass gooseneck type with an internal polypropylene lining that permits recirculation to the manual outlet.
- D. Needle Valves (Large): Provide large needle valves with a renewable valve seat and floating cone made of stainless steel or Monel metal with removable serrated outlet.
- E. Compression Water Valves: Provide units complying with ASME A112.18.1. Compression water valves shall have a renewable unit containing all working parts, including a stainless steel replaceable seat and valve disc. Unit shall be broached on the outside for permanent position in the valve body. The unit shall contain an integral control device for volume of water discharged by the faucet. The valve shall have a removable serrated hose unless otherwise noted. Valve shall be rated for 125 psi (857 kPa) operating pressure with a max of 190 psi (1303 kPa) for intermittent use.
- F. Faucet Accessories: Hot and cold water combination sink faucets shall have aerator tips. Cup sink and reagent grade water faucets to have serrated hose ends. Faucets are to be swivel type.
- G. Vacuum Breakers: ASSE 1035 Integral vacuum breakers, shall be supplied on all domestic water fixtures. The fume hood fixture shall have the vacuum breaker exposed 7 feet (2133.6mm) A.F.F. on face of hood (exposed vacuum breaker and piping to have same finish as other fixtures). The vacuum breaker for the eye wash fixture shall be located under the sink cabinet, visible when the cabinet doors are open.
- H. Hand Held Eye Wash: Where indicated with designation "EW" on floor plans, provide a unit that consists of a dual head eye wash assembly, 6 feet (1828.8mm) length of rubber hose, work surface mounting stand, slip ring mechanism to allow for hands free operation and in-line vacuum breaker. Unit's finish to match other service fittings.
- I. Service Identification. Index buttons mounted in fixture handles shall identify the following services. Buttons shall be color-coded and lettered.

<u>SERVICE</u>	<u>LETTERING</u>	<u>DISC</u>	<u>COLOR</u>
Hot Water	HW		Red
Cold Water	CW		Green
Gas	Gas		Blue
Air	Air		Orange
Vacuum	Vac		Yellow
Nitrogen	N2		Brown

- J. Service Fixture Finish. Laboratory brass service fixtures shall be ground smooth, coated with chromium plated finish with a clear epoxy coating. Fixtures shall receive multiple applications of coating and are baked for polymerization. Units must be assembled before coating and pressure tested before shipment.
- K. Fixture Shipment. Fixtures shall be assembled in factory and supplied loose except for fume hood factory mounted fixtures.

2.8 TALL FLAMMABLE STORAGE CABINET

A. Manufacturers:

- 1. Justrite Manufacturing Co. (Des Plaines, IL)
- 2. Eagle Manufacturing Co. (Wellsburg, WV)
- 3. Se-Cura-AI (La Porte, IN)
- 4. Or Equal

B. Product Description:

- 1. Conform to OSHA Regulations and the requirements of NFPA 30-2003 Chapter 6-3, National Fire Protection Association, Flammable and Combustible Liquids Code. Cabinets shall be Factory Mutual (FM) approved or Underwriters Laboratories (UL) listed. Cabinets shall limit the internal temperature at the center, 1 inch from the top to not more than 325 degrees Fahrenheit when subjected to a ten-minute fire test that simulates the fire exposure of the standard time-temperature curve specified in NFPA 251.
- 2. 45-gallon capacity, yellow cabinet shall be double walled, 18-gauge steel with 1-1/2" airspace. Doors shall be self-closing and self-latching on fusible link. One adjustable/removable shelf to be included. One ABS tray that fits on shelf or on bottom of cabinet to be provided. Bottom of cabinet shall be liquid tight to a height of 2". Dual 2" diameter high and low vent ports with flame arrestors and caps.
- 3. Identification: Apply silkscreen signage, color red, in a conspicuous size to cabinet doors indicating "FLAMMABLE – KEEP FIRE AWAY"
- 4. Dimensions: 43"W x 18"D x 65"H
- 5. Installation: Floor mounted with seismic restraint
- 6. Ventilation: Do not ventilate cabinet unless required by local authorities. Seal vent opening with plugs supplied by manufacturer if ventilation is not required. Provide flame arrestor on cabinet vent outlets if ventilation is required.
- 7. Grounding: Provide a grounding lug connection at back of cabinet. Coordinate connection with Division 26.

C. Unit shall be equal to Justrite Sure-Grip EX model 894520

2.9 CORROSIVES STORAGE CABINET

A. Manufacturers:

- 1. Justrite Manufacturing Co. (Des Plaines, IL)
- 2. Eagle Manufacturing Co. (Wellsburg, WV)
- 3. Se-Cura-AI (La Porte, IN)
- 4. Or Equal

B. Product Description:

- 1. Double door, wood cabinet construction, with stainless steel handles and hinges. (36) 2-1/2-liter bottle capacity, blue color. Provide one adjustable shelf on 1-1/4" centers. Cabinets shall include adjustable leg levelers and double key set. Provide a removable, polyethylene work surface, recessed 5/8" to contain spills.
- 2. Identification: Apply silkscreen signage, color yellow, in a conspicuous size to cabinet doors indicating "CAUTION – ACIDS/CORROSIVES"
- 3. Dimensions: 36"W x 22"D x 35-3/4"H
- 4. Installation: Floor mounted with seismic restraint
- 5. Ventilation: Cabinet to be vented to building supply and exhaust system.

C. Unit shall be equal to Justrite Sure-Grip EX model 894520

2.10 ELECTRICAL FIXTURES

- A. General. Provide electrical fixtures in accordance with requirements in Division 26, complete with metal enclosure boxes, receptacles, terminals, switches, pilot lights, device plates, accessories and grommets. Cover plates to be stainless steel. Standard receptacles shall be white, receptacles connected to emergency power shall be red.
- B. Electrical Raceways.
 - 1. Electrical raceways mounted directly to partitions, reagent shelves or slotted studs will be supplied and installed under Division 26 Electrical.
- C. Pedestal Outlets. Pedestal outlets shall be provided where noted (E9, E10, D10). They shall be fabricated of cast aluminum, sloped single face or two faces, as indicated, with neoprene gasket under base and with concealed mounting holes in base for attaching to laboratory casework. Provide holes tapped for conduit and be finished with a brushed finish to match the Electrical Raceway.

2.11 UMBILICALS

- A. Vertical service columns shall extend from the work surface to a minimum of 6 inches (150mm) above the hung finished ceiling and secured at bottom and top to insure structural stability.
- B. Umbilical shall be fabricated and finished the same as the laboratory casework. Color to be selected by the Owner's Representative.
- C. Umbilicals shall have a removable access panel, screwed in place, on unobstructed side. One unobstructed side (opposite side with conduit cut-outs).
- D. Provide 6 inch (152mm) high curb around umbilical of the same material as work surface with corners mitered. Provide cut-out in work surface centered under the service column to accommodate services from above as indicated on the Drawings. Coordinate and provide cut-outs on face of umbilical for feeds to electrical raceway and panel mounted fixtures.

2.12 CEILING SERVICE PANELS

- A. The Ceiling Service Panel (CSP) is a rigid mounting surface for laboratory utilities distributed along the centerline of a laboratory bench group. Panels are designed to accommodate medical grade quick connect fittings for the distribution of specialty gases. CSP is designed to fit most suspended t-bar grid ceiling systems and is specified in a 6 inch width. Panel lengths will be as noted on drawings.
- B. Utilities on the laboratory bench connect to the CSP via cables incorporating twist-lock or flexible tubing with quick-disconnect fittings. Overhead utility supply from the CSP allows for flexibility and mobility of laboratory services without the need to penetrate floors and walls.
- C. CSP shall be fabricated from 11-gage cold rolled steel with urethane or epoxy powder coated finish. All four edges of each panel shall be flanged to a depth of 3/4 inch. Flanges shall have a maximum 1/16 inch radius and shall be welded at intersecting corners to improve rigidity. Nominal panel width as indicated on drawings. Panel lengths will vary and are indicated on the Drawings. Height of the panel varies with the size of utility fittings attached. Panels shall be fabricated with openings and mounting holes for all utility fittings. Final finish shall be applied after all flanges, openings and holes are fabricated.
- D. CSP will be detailed in the laboratory construction documents (CSP1). All quick disconnect fittings, distribution tubing and gas hoses shall be supplied with the CSP by Division 12.
- E. Laboratory casework components and assemblies shall meet local seismic restraint requirements.

2.13 PEGBOARDS

- A. Stainless Steel pegboards, as manufactured by Inter Dyne Systems, Inc. (Norton Shores, MI.) or United Lab Equipment, (Depew, NY) shall be furnished with removable rounded-tip white polypropylene pegs.

- B. Glass Drying Racks mounted above pegboards shall be stainless steel as manufactured by Inter Dyne Systems, Inc. (Norton Shores, MI.).
- C. Stainless steel drip trough, ¼" (6mm) diameter drip trough outlet and flexible black, white or gray rubber tubing between drip trough outlet and sink (cut as required).
- D. Pegboards at umbilical shall be furnished with integral clips to attach to standards. Pegboard size and configuration shall be as indicated on the Drawings.
- E. Provide continuous silicone sealant at intersection between pegboard and trough.

2.14 C CYLINDER RACKS

- A. General: Furnish and install wall mounted cylinder racks, in locations indicated on the Drawings.
- B. Manufacturers: Cylinder racks shall be fabricated of steel channels similar to products by:
 1. Uni strut Corporation (Wayne, MI)
 2. Kindorf (Baltimore, MD)
 3. Power Strut. (Shrewsbury, MA)
 4. Products similar to the Unistrut P1000 series, 12 gage, in lengths indicated on the Drawings along with associated accessories, including but limited to bolts and spring nuts. Channels and parts shall be furnished to laboratory casework manufacturer in their standard acid resistant epoxy powder coat finish. Color to be selected by the Owner's Representative.
 5. Accessories: Cylinder strap holders angle fittings, two per cylinder, with one inch nylon strapping, safety belt buckle and quick disconnect similar to Model # 29695T56 / 29695T66 as manufactured by McMaster-Carr Supply Company (New Brunswick, NJ.)

2.15 OVERHEAD UTILITY SERVICE CARRIER

- A. Description: Construct of metal framing system components as manufactured by Unistrut Corporation, Elcen, Grinnell Power-Strut, or equal. Unistrut part numbers are referenced.
- B. The entire assembly, including diagonal braces, shall be securely and rigidly fastened to structural slab above or to a structural grid where provided.
- C. Paint assembly with color selected by the Owner's Representative.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of plastic-laminate laboratory casework.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CABINETS

- A. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.
- C. Base Cabinets: Adjust to p rails and sub-tops within 1/16 inch (1.5 mm) of a single plane. Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions in accordance with AWI Section 1700-G-9. Fasten adjacent cabinets together with

joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch (1.5 mm).

1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches (600 mm) o. c. and at sides of cabinets with not less than 2 fasteners per side.
- D. Wall Cabinets: Adjust fronts and bottoms within 1/16 inch (1.5 mm) of a single plane. Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, in accordance with AWI Section 1700-G-9. Align similar adjoining doors to a tolerance of 1/16 inch (1.5 mm).
- E. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
- F. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF COUNTERTOPS

- A. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.
- B. Field Jointing: Where possible, make in the same manner as shop jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop.
- C. Fastening:
1. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
 2. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches (1200 mm) o.c.
 3. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch (3 mm) and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.
- D. Provide required holes and cutouts for service fittings.
- E. Provide scribe moldings for closures at junctures of countertop, curb, and splash, with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.
- F. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.4 INSTALLATION OF SINKS

- A. Underside Installation of Epoxy Sinks: Use laboratory casework manufacturer's recommended adjustable support system for table- and cabinet-type installations. Set top edge of sink unit in sink and countertop manufacturers' recommended chemical-resistant sealing compound or adhesive and firmly secure to produce a tight and fully leak-proof joint. Adjust sink and securely support to prevent movement. Remove excess sealant while still wet and finish joint for neat appearance.
- B. Drop-in Installation of Epoxy Sinks: Rout groove in countertop to receive sink rim if not prepared in shop. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.

3.5 INSTALLATION OF ACCESSORIES

- A. Install accessories according to Shop Drawings and manufacturer's written instructions. Adjust moving parts to operate freely without excessive bind.
- B. Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.
- C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.

3.6 INSTALLATION OF SERVICE FITTINGS

- A. Comply with requirements in Divisions 15 and 26 Sections for installing water and laboratory gas service fittings, piping, electrical devices, and wiring.
- B. Install fittings according to Shop Drawings and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings, piping, and conduit to laboratory casework, unless otherwise indicated.

3.7 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- B. Protect countertop surfaces during construction with 6-mil (0.15-mm) plastic or other suitable water-resistant covering. Tape to underside of countertop at minimum of 48 inches (1200 mm) o.c. Cover the plastic with 1/4" (6mm) corrugated cardboard or equal completely covering the top and securely taped to edges. Mark cardboard in large lettering: "NO STANDING".

END OF SECTION

SECTION 220000 GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

- A. Basic plumbing requirements specifically applicable to Division 22 Sections.
- B. Work includes but is not necessarily limited to the following:
 - 1. Labor, materials, services, equipment, and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary to prepare spaces and systems for new installations as follows:
 - a. Heating, ventilating and air conditioning systems and equipment
 - b. Plumbing systems and equipment

1.3 DRAWINGS AND SPECIFICATIONS

- A. Drawings accompanying these Specifications show intent of Work to be done. Specifications shall identify quality and grade of installation and where equipment and hardware is not particularly specified, Contractor shall provide submittals for all products and install them per manufacturers' recommendations, and in a first class manner.
- B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.
- C. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after the University has reviewed equipment, as Work progresses, to conform in best possible manner with surroundings, and as directed by the University's Representative.
- D. Contract Documents are in part diagrammatic and intended to show the scope and general arrangement of the Work under this Contract. The Contractor shall follow these drawings in laying out the equipment, piping and ductwork. Drawings are not intended to be scaled for roughing in measurements or to serve as shop drawings. Where job conditions require minor changes or adjustments in the indicated locations or arrangement of the Work, such changes shall be made without change in the Contract amount.
- E. Follow dimensions without regard to scale. Where no figures or notations are given, the Plans shall be followed.

1.4 UTILITIES

- A. Location and sizes of electrical, mechanical and plumbing service facilities are shown in accordance with data secured from existing record drawings and site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Check and verify all data given, and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.

1.5 APPLICABLE REFERENCE STANDARDS, CODES AND REGULATIONS:

- A. Meet requirements of all state codes having jurisdiction.
- B. State of California Code of Regulations:
 - 1. Title 8, Industrial Relations
 - 2. Title 19, State Fire Marshal Regulations
 - 3. Current California Building Code (CBC), Title 24, Part 2
 - 4. Current California Electrical Code, Title 24, Part 3
 - 5. Current California Mechanical Code, Title 24, Part 4
 - 6. Current California Plumbing Code, Title 24, Part 5
 - 7. Current California Fire Code, Title 24, Part 9
 - 8. Current California Standards Code, Title 24, Part 12
 - 9. Title 24, Energy Conservation Standards
- C. Additional Referenced Standards:
 - 1. AABC Associated Air Balance Council
 - 2. AMCA Air Moving and Conditioning Association
 - 3. ARI Air-Conditioning and Refrigeration Institute
 - 4. ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
 - 5. ASME American Society of Mechanical Engineers
 - 6. ASTM American Society for Testing and Materials
 - 7. NEMA National Electrical Manufacturer's Association
 - 8. NFPA National Fire Protection Association Standards
 - 9. PDI Plumbing and Drainage Institute
 - 10. UL Underwriters Laboratories
- D. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements, which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Should there be any conflicts between Contract Documents or codes or any ordinances having jurisdiction, report these to the University's Representative.
- E. Obtain permits, and request inspections from authority having jurisdiction.

1.6 PROJECT AND SITE CONDITIONS

- A. The arrangement of and connection to equipment shown on the drawings is based upon information available and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements. Structural supports, housekeeping pads, piping connections and adjacent equipment may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions or alterations.
- B. Examine all Drawings and Specifications to be fully cognizant of all work required under this Division.
- C. Examine site related work and surfaces before starting work of any Section.
- D. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.
- E. Prepare revised shop drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the

University's Representative before proceeding.

- F. Beginning work of any Section constitutes acceptance of conditions.

1.7 COOPERATION WITH WORK UNDER OTHER DIVISIONS

- A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.
- B. Work under this Division shall follow general building construction closely. Set pipe sleeves and inserts and verify that openings for chases and pipes are provided.
- C. Work with other trades in determining exact location of outlets, pipes, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.
- D. Make such progress in the Work to not delay work of other trades.
- E. Mechanical Work shall have precedence over the other in the following sequence:
 - 1. Soil and waste piping
 - 2. Hydronic piping
 - 3. Ductwork
 - 4. Fire sprinkler piping
 - 5. Domestic water piping

1.8 DISCREPANCIES

- A. The Contractor shall check all Drawings furnished him immediately upon their receipt and shall promptly notify the University's Representative of any discrepancies. Figures marked on Drawings shall in general be followed in preference to scale measurements. Piping and instrumentation diagrams shall in general govern floor plans and sections. Large-scale drawings shall in general govern small-scale drawings.
- B. Where requirements between Drawings and Specifications conflict, the more restrictive provisions shall apply.
- C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to University's Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without University Representatives decision. Beginning work of any Section constitutes acceptance of conditions.

1.9 CHANGES

- A. The Contractor shall be responsible to make and obtain approval from the University's Representative for all necessary adjustments in piping and equipment layouts as required to accommodate the relocations of equipment and/or devices, which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.

1.10 SUBMITTALS

- A. Refer to Division 01 for additional requirements.
- B. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.

1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- C. Note that prior to acceptance of shop drawings for review, a submittal schedule shall be submitted to the University's Representative.
- D. Submit all Division 23 shop drawings and product data grouped and referenced by the specification technical section numbers in one complete submittal package.
- E. Shop Drawings:
1. Provide all shop drawings in latest version of AutoCAD format.
 2. Drawings shall be a minimum of 8.5 inches by 11 inches in size with a minimum scale of 1/4-inch per foot, except as specified otherwise.
 3. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
 4. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
 5. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.
- F. Whenever more than one (1) manufacturer's product is specified, the first named product is the basis of design used in the Work and the use of alternate-named manufacturer's products or substitutes may require modifications in that design.
- G. Proposed Products List: Include Products as required by the individual section in this Division.
- H. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the University's Representative bearing the University's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the University's Representative without additional compensation.
- I. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
- J. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or American Water Works Association (AWWA), submit proof of such conformance to the University Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the University Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.
- K. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
- L. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall

name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

1.11 PRODUCT ALTERNATIVES OR SUBSTITUTIONS

- A. Refer to Division 01 for additional requirements.

1.12 GUARANTEE

- A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of one year from date of project acceptance against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the University.
- B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the University for their service agency as directed.

1.13 OPERATION AND MAINTENANCE MANUAL

- A. Refer to Division 01 for additional requirements.

1.14 POSTED OPERATING INSTRUCTIONS

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.
- B. The operating instructions shall include control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions as directed. Attach or post operating instructions adjacent to each principal system and equipment. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.15 INSTRUCTION TO THE UNIVERSITY PERSONNEL

- A. Refer to Division 1 for additional requirements.
- B. Provide training as specified in individual sections.
- C. Before final inspection, instruct the University's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times. Furnish the services of competent instructors to give full instruction to the University personnel in the adjustment, operation, and maintenance of systems and equipment, including pertinent safety requirements. Each instructor shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.
- D. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

- E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with the University's personnel in detail to explain all aspects of operation and maintenance.
- F. Contractor shall video tape all in service training and instruction sessions and provide DVD, properly indexed, for training additional and future maintenance personnel.
- G. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- H. Submit six copies of Manufacturer's Instruction Certificates as specified in individual specification Sections.

1.16 MANUFACTURER'S RECOMMENDATIONS

- A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

1.17 PROJECT RECORD DOCUMENTS

- A. Refer to Division 1 for additional requirements.
- B. Maintain on site, one set of the following record documents; record actual revisions to the Work:
 - 1. Contract Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other Modifications to the Contract.
 - 5. Reviewed shop drawings, product data, and samples.
- C. Store Record Documents separate from documents used for construction. Record documents shall be available for review by the Construction Inspector and Engineer at all times.
- D. Record information concurrent with construction progress.
- E. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and Modifications.
- F. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Field changes of dimension and detail.
 - 2. Details not on original Contract Drawings.
 - 3. Provide all record documents and shop drawings in electronic format.
- G. All changes, deviations and information recorded on the "Project Record Drawings" set during Construction shall be redrafted onto the latest version of AutoCAD.
 - 1. Contractor hand marked or drafted redlined "Project Record Drawings" will not be accepted.
- H. Submit completed shop drawings to the University prior to completion in AutoCAD format.

1.18 DELIVERY AND STORAGE

- A. Refer to Division 1 for additional requirements.
- B. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance During Construction." Replace damaged or defective items with new items.

1.19 EXTRA MATERIALS

- A. Refer to Division 1 for additional requirements.
- B. Unless otherwise specified, spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly type inventory of spare parts shall be taped to the underside of the cover.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

- A. Obtain and pay for all permits and inspections, including any independent testing required to verify standard compliance, and deliver certificates for same to the University's Representative.

3.2 WORK RESPONSIBILITIES

- A. The drawings indicate diagrammatically the desired locations or arrangement of piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions.
- B. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.
- C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the ductwork, piping, etc. and work directly connected to same is installed and no extra materials are required.
- D. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.
- E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the

drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.

- F. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify the University immediately and cease work on all parts of the contract, which are affected until approval for any required modifications to the construction has been obtained from the University.
- G. Be responsible for any cooperative work, which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the University and shall be made to his satisfaction. Perform all Work with competent and skilled personnel.
- H. All work, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.
- I. Replace or repair, without additional compensation, any work, which, in the opinion of the University, does not comply with these requirements.

3.3 PAINTING

- A. Refer to Division 09 9000 Painting for additional requirements.
- B. Factory Applied:
 - 1. Plumbing equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.
 - 2. Refer to individual sections of this Division for more stringent requirements.
- C. Field Applied:
 - 1. Paint all plumbing equipment as required to touch up, to match finish on other equipment in adjacent spaces or to meet safety criteria.
 - 2. Paint all exposed plumbing piping, valves, supports, hangers and appurtenances. Provide minimum 5 mils dry film thickness.
 - 3. Paint shall be a high performance polyurethane enamel coating system.
 - 4. Acceptable primer manufacturers include:
 - a. Ameron Amershield VOC, Tnemec's Series 1075 (1074) Endura-Shield, semi-gloss (gloss) sheen or equal.
 - 5. Acceptable paint manufacturers include:
 - a. Ameron, Tnemec or engineer approved equal.

END OF SECTION

SECTION 220500 COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Concrete bases.
 - 11. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
 1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For the following:
 1. Transition fittings.
 2. Dielectric fittings.
 3. Mechanical sleeve seals.
 4. Escutcheons.
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

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 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Available Manufacturers:

- a. Dresser Industries, Inc.; DMD Div.
 - b. Smith-Blair, Inc.
 - c. 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.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.

- G. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: 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.

2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated

finish.

- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi , 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.

- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve

for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Refer to Division 09 9000 Painting for additional requirements.
- B. Paint all plumbing equipment as required to touch up, to match finish on other equipment in adjacent spaces or to meet safety criteria.
- C. Paint all exposed plumbing piping, valves, supports, hangers and appurtenances. Provide minimum 5 mils dry film thickness.
- D. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

SECTION 220516
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Grooved-joint expansion joints.
 - 2. Pipe loops and swing connections.
 - 3. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
- C. Welding certificates.
- D. Product Certificates: For each type of expansion joint, from manufacturer.
- E. Maintenance Data: For expansion joints to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 GROOVED-JOINT EXPANSION JOINTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Anvil International, Inc.
 - 2. Shurjoint Piping Products.
 - 3. Victaulic Company.
- B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
- C. Standard: AWWA C606, for grooved joints.
- D. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.
- E. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, EPDM gasket suitable for cold and hot water, and bolts and nuts.

2.2 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Adscos Manufacturing LLC.
 - b. Advanced Thermal Systems, Inc.
 - c. Flex-Hose Co., Inc.
 - d. Flexicraft Industries.
 - e. Flex-Weld, Inc.
 - f. Hyspan Precision Products, Inc.
 - g. Metraflex, Inc.
 - h. Senior Flexonics Pathway.
 - i. Unisource Manufacturing, Inc.
 - j. U.S. Bellows, Inc.
 - 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.
- B. Anchor Materials:
 - 1. Steel Shapes and Plates: ASTM A 36/A 36M.
 - 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
 - 3. Washers: ASTM F 844, steel, plain, flat washers.
 - 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- C. Install rubber packless expansion joints according to FSA-NMEJ-702.
- D. Install grooved-joint expansion joints to grooved-end steel piping

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
 3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
1. Anchor Attachment to Steel Structural Members: Attach by welding.
 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION

**SECTION 220519
METERS AND GAGES FOR PLUMBING PIPING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Liquid-in-glass thermometers.
2. Dial-type pressure gages.
3. Gage attachments.
4. Test plugs.
5. Test-plug kits.
6. Sight flow indicators.

- B. Related Sections:

1. Division 21 Section "Facility Fire-Suppression Water-Service Piping" for fire-protection water-service meters outside the building.
2. Division 21 fire-suppression piping Sections for fire-protection pressure gages.
3. Division 22 Section "Facility Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
4. Division 22 Section " Domestic Water Piping" for water meters inside the building.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For each type of meter and gage, from manufacturer.
- C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - a. Terice, H. O. Co.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Back angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red] organic liquid.

6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
9. Connector: 3/4 inch, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 2. Standard: ASME B40.100.
 3. Case: Sealed type(s); cast aluminum or drawn steel 4-1/2-inch nominal diameter.
 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 6. Movement: Mechanical, with link to pressure element and connection to pointer.
 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
 8. Pointer: Dark-colored metal.
 9. Window: Glass].
 10. Ring: Stainless steel.
 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.3 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.4 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flow Design, Inc.
 2. Miljoco Corporation.
 3. National Meter, Inc.
 4. Peterson Equipment Co., Inc.
 5. Sisco Manufacturing Company, Inc.
 6. Trerice, H. O. Co.
 7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 8. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

- D. Thread Size: NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F .
- F. Core Inserts: EPDM self-sealing rubber.

2.5 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flow Design, Inc.
 - 2. Miljoco Corporation.
 - 3. National Meter, Inc.
 - 4. Peterson Equipment Co., Inc.
 - 5. Sisco Manufacturing Company, Inc.
 - 6. Trerice, H. O. Co.
 - 7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 8. Weiss Instruments, Inc.
- B. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
- D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- F. Carrying Case: Metal or plastic, with formed instrument padding.

2.6 SIGHT FLOW INDICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1. Archon Industries, Inc.
 - 2. Dwyer Instruments, Inc.
 - 3. Emerson Process Management; Brooks Instrument.
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 125 psig.
- E. Minimum Temperature Rating: 200 deg F.
- F. End Connections for NPS 2 and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install remote-mounted pressure gages on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.
- J. Install test plugs in piping tees.
- K. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
 - 2. Inlets and outlets of each domestic water heat exchanger.
 - 3. Inlet and outlet of each domestic hot-water storage tank.
- L. Install pressure gages in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each pressure-reducing valve.
 - 3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
 - 1. Sealed, bimetallic-actuated type.
 - 2. Direct-mounted, metal-case, vapor-actuated type.
 - 3. Compact-style, liquid-in-glass type.

4. Direct-mounted, light-activated type.
 5. Test plug with EPDM self-sealing rubber inserts.
- B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
1. Sealed, bimetallic-actuated type.
 2. Direct-mounted, metal-case, vapor-actuated type.
 3. Compact-style, liquid-in-glass type.
 4. Direct-mounted, light-activated type.
 5. Test plug with EPDM self-sealing rubber inserts.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F.
- B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be one of the following:
 1. Liquid-filled-mounted, metal case.
 2. Sealed -mounted, plastic case.
 3. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping: 0 to 100 psi.

END OF SECTION

**SECTION 220523
GENERAL-DUTY VALVES FOR PLUMBING PIPING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
 - 2. Bronze swing check valves.
 - 3. Bronze gate valves.
- B. Related Sections:
 - 1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
 - 2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
 - 3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
 - 1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
 - 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. 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 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Handwheel: For valves other than quarter-turn types.
 - 2. Handlever: For quarter-turn valves NPS 6 and smaller.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES (LEAD FREE)

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

2.3 BRONZE SWING CHECK VALVES (LEAD FREE)

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.

2.4 BRONZE GATE VALVES (LEAD FREE)

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

B. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron.

2.5 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

2.6 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

2.7 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.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for gate and globe valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
 1. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.2 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 1. Shutoff Service: Ball valves.
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
 - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

3.4 DOMESTIC, HOT AND COLD WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, bronze disc.
3. Ball Valves: Two piece, full port, bronze with bronze trim.
4. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
4. Iron Gate Valves: Class 125, NRS.
5. Iron Globe Valves: Class 125.

END OF SECTION

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
 - 1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification

- section.
2. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For the following:
1. Steel pipe hangers and supports.
 2. Thermal-hanger shield inserts.
 3. Powder-actuated fastener systems.
 4. Pipe positioning systems.
- C. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze pipe hangers. Include Product Data for components.
 2. Metal framing systems. Include Product Data for components.
 3. Fiberglass strut systems. Include Product Data for components.
 4. Pipe stands. Include Product Data for components.
 5. Equipment supports.
- D. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."
 2. AWS D1.2, "Structural Welding Code--Aluminum."
 3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.

2. ERICO/Michigan Hanger Co.
3. Tolco Inc.

- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 3. Tolco Inc.
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
- a. Hilti, Inc.
 - b. Masterset Fastening Systems, Inc.
 - c. MKT Fastening, LLC.
 - d. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
- a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Hilti, Inc.
 - c. Powers Fasteners.

2.6 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-

resistant components to support roof-mounted piping.

- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
1. Manufacturers:
 - a. MIRO Industries.
- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - c. Portable Pipe Hangers.
 2. Base: Stainless steel.
 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
1. Manufacturers:
 - a. Portable Pipe Hangers.
 2. Bases: One or more plastic.
 3. Vertical Members: Two or more protective-coated-steel channels.
 4. Horizontal Member: Protective-coated-steel channel.
 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Manufacturers:
1. C & S Mfg. Corp.
 2. HOLDRITE Corp.; Hubbard Enterprises.

3. Samco Stamping, Inc.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 3. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 6. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 7. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 8. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 9. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of

- noninsulated stationary pipes, NPS 3/8 to NPS 3.
10. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 12. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 13. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 14. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 15. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 16. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 17. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 18. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 19. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. 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.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to

- flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 13. Light (MSS Type 31): 750 lb.
 - a. Medium (MSS Type 32): 1500 lb.
 - b. Heavy (MSS Type 33): 3000 lb.
 14. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 15. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 16. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not

specified in piping system Sections.

- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- I. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for

plumbing fixtures.

- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- M. Install lateral bracing with pipe hangers and supports to prevent swaying.
- N. 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.
- O. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- Q. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
 - 1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
 - 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product indicated.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- E. Valve numbering scheme.
- F. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: 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.
 - 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 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.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Brass.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass beaded chain or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 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 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet 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 labels.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
 - 2. Valve-Tag Color:

- a. Hot and Cold Water: Natural.
3. Letter Color:
- a. Hot and Cold Water: Black.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 220700 PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials: Mineral fiber
 - 2. Adhesives.
 - 3. Field-applied jackets.

1.3 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
 - 1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
 - 2. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For product indicated. Include thermal conductivity, thickness, and jackets.
- C. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 3. Detail application of field-applied jackets.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
 - 1. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Johns Manville; Micro-Lok.
 - b. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Childers Products, Division of ITW; CP-82.

2.3 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

c. **Factory-Fabricated Fitting Covers:**

- 1) Same material, finish, and thickness as jacket.
- 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
- 3) Tee covers.
- 4) Flange and union covers.
- 5) End caps.
- 6) Beveled collars.
- 7) Valve covers.
- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

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.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.

- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 4. For below ambient services, apply vapor-barrier mastic over staples.
 5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Insulation Installation on Fittings, Valves, Flanges, and Unions:
1. Install insulation over fittings, valves, 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 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.
 6. 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.
- B. 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.

3.5 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.

- B. Where 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.

- C. 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.

END OF SECTION

SECTION 221116 DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Encasement for piping.
 - 3. Specialty valves.
 - 4. Flexible connectors.
 - 5. Escutcheons.
 - 6. Sleeves and sleeve seals.
 - 7. Wall penetration systems.
 - 8. Transitions fittings.
 - 9. Dielectric fittings.
- B. Related Section:
 - 1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

1.4 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
 - 1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
 - 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Backflow preventers and vacuum breakers.
 - 6. Escutcheons.

7. Sleeves and sleeve seals.
 8. Water penetration systems.
- 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. Domestic water piping.
 2. HVAC hydronic piping.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

1.6 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.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Mueller Industries
 2. Cerro Industries
 3. Nibco
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 1. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 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. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- E. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Form: Tube.
- C. Material: High-density, cross-laminated PE film of 0.004-inch minimum thickness.

2.5 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.6 TRANSITION FITTINGS

- A. General Requirements:
 1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dresser, Inc.; Dresser Piping Specialties.
 - b. Romac Industries, Inc.
 - c. Smith-Blair, Inc; a Sensus company.
 - d. Viking Johnson; c/o Mueller Co.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - b. Zurn Plumbing Products Group; Wilkins Water Control Products.
 - 2. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.

2.8 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flex-Hose Co., Inc.
 - 2. Hyspan Precision Products, Inc.
 - 3. Metraflex, Inc.
 - 4. Proco Products, Inc.
 - 5. Universal Metal Hose; a Hyspan company
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.9 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
- C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.
- D. One Piece, Stamped Steel: Chrome-plated finish with setscrew.
- E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

- F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew.
- G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.10 SLEEVES

- A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- D. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
- E. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.11 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Calpico, Inc.
 - 2. Metraflex, Inc.
 - 3. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
 - 1. Pressure Plates: Stainless steel.
 - 2. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.12 WALL PENETRATION SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. SIGMA.
- B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
 - 1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
 - 2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
 - 3. Housing-to-Sleeve Gasket: NBR.
 - 4. Housing-to-Carrier-Pipe Gasket: AWWA C111, NBR.
 - 5. Pipe Sleeve: AWWA C151, ductile-iron pipe or ASTM A 53/A 53M, Schedule 40, zinc-

coated steel pipe.

2.13 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified. If Drawings are explicit enough, these requirements may be reduced or omitted.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- D. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- E. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.
- F. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- G. Install shutoff valve immediately upstream of each dielectric fitting.
- H. Install domestic water piping level and plumb.
- I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- J. 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.
- K. Install piping adjacent to equipment and specialties to allow service and maintenance.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher

than system pressure rating used in applications below unless otherwise indicated.

- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- H. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
- I. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.
- J. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- C. Provide shut-off valve downstream of each point of connection to existing piping.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.6 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.
- B. Install bronze-hose flexible connectors in copper domestic water tubing.
- C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - 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. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for 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.
 6. NPS 6: 10 feet with 5/8-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2 : 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
- G. Install supports for vertical steel piping every 15 feet.
- H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
 2. 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.

3.9 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
 5. Bare Piping in Equipment Rooms: One piece, cast brass.
 6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.10 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using wall penetration systems specified in this Section.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
 - 1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
 - 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 3. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
 - 4. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
 - c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - d. Do not use sleeves when wall penetration systems are used.

3.11 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.12 WALL PENETRATION SYSTEM INSTALLATION

- A. Install wall penetration systems in new, exterior concrete walls.
- B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.13 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.14 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.15 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.16 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm 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.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.17 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in

applications below unless otherwise indicated.

- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. The "Piping Schedule" Article below is organized to first present the service and pipe size or size range;
- D. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K with no joints.
- E. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
 - 1. Soft copper tube, ASTM B 88, Type K with no joints.
- F. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
 - 1. Hard copper tube, ASTM B 88, Type L with wrought-copper solder-joint fittings; and soldered joints.
- G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
 - 1. Hard copper tube, ASTM B 88, Type L with wrought-copper solder-joint fittings; and soldered joints.

3.18 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

SECTION 221119 DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Strainers.
4. Hose bibbs.
5. Drain valves.
6. Trap-seal primer systems.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
 1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
 2. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Diagram power, signal, and control wiring.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn
 - b. MIFAB, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Woodford Manufacturing Company.
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.2 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller.
3. End Connections: Threaded for NPS 2 and smaller.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.3 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 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 non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.

14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.4 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB Inc.
 - b. ZURN, Inc.
2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Recessed-mounting steel box with stainless-steel cover.
5. Vacuum Breaker: ASSE 1001.
6. Number Outlets: Four.
7. Size Outlets: NPS 1/2.
8. Pressure Drop: 3 psi or less.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install temperature-actuated water mixing valves with 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 on supply side of each control valve and pump.
- F. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with

requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

- B. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Reduced-pressure-principle backflow preventers.
 - 3. Outlet boxes.
 - 4. Hose stations.
 - 5. 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 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

**SECTION 221316
SANITARY WASTE AND VENT PIPING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.

1.3 DEFINITIONS

- A. PE: Polyethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Sanitary Sewer, Force-Main Piping: 50 psig.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
 - 1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
 - 2. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For pipe, tube, fittings, and couplings.
- C. Shop Drawings:
 - 1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
- D. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. AB&I
 - 2. Tyler
 - 3. Charlotte

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy classes.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
 - a. Manufacturers:
 - 1) Husky.
 - 2) Tyler Pipe; Soil Pipe Div.
 - 2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Manufacturers:

- 1) Husky.
- 2) Tyler Pipe; Soil Pipe Div.

2.5 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
- B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.
- C. Pressure Fittings:
 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, 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, galvanized, standard pattern.
 4. Cast-Iron Flanges: ASME B16.1, Class 125.
 5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.

2.6 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- C. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2.7 ENCASUREMENT FOR UNDERGROUND METAL PIPING

- A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch minimum thickness.
- B. Form: tube.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 - 1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
 - 2. Copper DWV tube, copper drainage fittings, and soldered joints.
- C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 - 1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
 - 2. Copper DWV tube, copper drainage fittings, and soldered joints.
- D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
 - 1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel or heavy-duty shielded, cast-iron couplings; and hubless-coupling joints.

3.2 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- D. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- E. 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.
- F. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- 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."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- 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: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent 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 22 Section "Common Work Results for Plumbing."
- B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- E. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.4 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- 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 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.
- D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
 - 1. Horizontal Piping: Horizontal backwater valves.
 - 2. Floor Drains: Install backwater valves in accessible locations.

3. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- 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. Maximum spans below were taken from MSS SP-69 for water service and from model plumbing codes. Most restrictive piping and spacing dimensions are shown.
- G. 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.
- H. Install supports for vertical cast-iron soil piping every 15 feet .
- I. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
- J. Install supports for vertical steel piping every 15 feet.
- K. 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.

L. Install supports for vertical copper tubing every 10 feet.

3.6 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 (DN 65) and larger.

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 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 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.8 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

SECTION 221319 SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Floor sinks.
4. Catch basin.
5. Roof flashing assemblies.
6. Through-penetration firestop assemblies.
7. Miscellaneous sanitary drainage piping specialties.
8. Flashing materials.

1.3 DEFINITIONS

- A. Retain acronyms and abbreviations that remain after this Section has been edited.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
 1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
 2. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product indicated in Part 2
- C. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Zurn Plumbing Products Group; Light Commercial Operation.
 - 2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
 - 3. Size: Same as connected branch.
 - 4. Type: Threaded, adjustable housing.
 - 5. Body or Ferrule: Cast iron.
 - 6. Outlet Connection: Spigot
 - 7. Closure: bronze plug and non-skid nickel bronze top.
 - 8. Adjustable Housing Material: Cast iron with threads.
 - 9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.

10. Frame and Cover Shape: Round.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
13. Standard: ASME A112.3.1.
14. Size: Same as connected branch.
15. Housing: Stainless steel.
16. Closure: Stainless steel with seal.
17. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Option for drilled-and-threaded plug in first subparagraph below is for a screw for a wall cover plate.
6. Closure: Countersunk plug.
7. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
8. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Zurn
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Coating in first subparagraph below is usually used only on sanitary floor drains.
10. Top or Strainer Material: Stainless steel.
11. Top of Body and Strainer Finish: Stainless steel.
12. Top Shape: Round.
13. Dimensions of Top or Strainer: 6"
14. Top Loading Classification: Heavy Duty
15. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
16. Trap Material: Cast iron.
17. Trap Pattern: Standard P-trap.
18. Trap Features: Trap-seal primer valve drain connection.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Zurn
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
2. Standard: ASME A112.6.3.
3. Pattern: Floor sink.
4. Body Material: Cast iron enamel coated interior.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Coating in first subparagraph below is usually used only on sanitary floor drains.
10. Top or Strainer Material: Stainless steel.
11. Top of Body and Strainer Finish: Stainless steel.
12. Top Shape: Square.
13. Dimensions of Top or Strainer: 6"
14. Top Loading Classification: Heavy Duty
15. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
16. Trap Material: Cast iron.
17. Trap Pattern: Standard P-trap.
18. Trap Features: Trap-seal primer valve drain connection.

2.4 CATCH BASIN

A. Catch Basin:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brooks
 - b. M.C. Nottingham.
 - c. Pyramid Precast
2. Standard: ASME A112.6.3.
3. Pattern: Catch Basin.
4. Body Material: concrete.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Coating in first subparagraph below is usually used only on sanitary floor drains.
10. Top or Strainer Material: Stainless steel.
11. Top of Body and Strainer Finish: Stainless steel.
12. Top Shape: Square.
13. Dimensions of Top or Strainer: 6"
14. Top Loading Classification: Heavy Duty
15. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
16. Trap Material: Cast iron.

17. Trap Pattern: Standard P-trap.
18. Trap Features: Trap-seal primer valve drain connection.

2.5 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. Description: Manufactured assembly made of 4.0-lb/sq. ft. thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counter-flashing fitting.
 1. Open-Top Vent Cap: Without cap.
 2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Fitting in subparagraph below is for use with plastic stacks.
6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
7. Coating in subparagraph below is for use with corrosion-resistant plastic stacks.
8. Special Coating: Corrosion resistant on interior of fittings.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

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 1 inch 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. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.8 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. 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 roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- H. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
- I. Assemble open drain fittings and install with top of hub 1 inch above floor.
- J. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- K. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

2. Size: Same as floor drain inlet.
- L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
 - M. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
 - N. Install vent caps on each vent pipe passing through roof.
 - O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
 - P. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
 - Q. Install wood-blocking reinforcement for wall-mounting-type specialties.
 - R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
 - S. 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 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, 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.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

END OF SECTION

SECTION 222112 FUEL GAS PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes fuel gas piping, specialties, and accessories within the building and site distribution.

1.2 PROJECT CONDITIONS

- A. Site Gas System Pressure: 5.0 psig
- B. Building Gas System Pressure: Primary pressure is 5 psig reduced to secondary pressure of 8 Inch of Water Column.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Polyethylene piping systems. Include associated components.
 - 2. Specialty valves. Include pressure rating, capacity, settings of selected models.
 - 3. Service meters. Provided by Gas Company.
 - 4. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
- B. Shop Drawings: For fuel gas piping. Include plans and attachments to other Work.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. ANSI Standard: Comply with ANSI Z223.1, "National Fuel Gas Code."

1.5 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 subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Provide products by the manufacturers specified.

2.2 PIPING MATERIALS

- A. Steel Pipe: ASTM A 53; Schedule 40; black.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
 - 2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
 - 3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
 - 4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
 - 5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
 - 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.
- B. Transition Fittings: Type, material, and end connections to match piping being joined.
- C. Common Joining Materials: Refer to Division 15 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

2.3 SPECIALTIES

- A. Flexible Connectors: ANSI Z21.24, copper alloy.
- B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

2.4 VALVES

- A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
- B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
- C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.
- D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.
- E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.
- F. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Use flanges, unions, transition, and special fittings in applications below, unless otherwise indicated.
 - 1. NPS 3/4 and NPS 1: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 1-1/4 to NPS 4: Steel pipe, malleable-iron threaded fittings, and threaded joints.

3. NPS 1-1/4 to NPS 4: Steel pipe, steel welding fittings, and welded joints.
4. Larger Than NPS 4: Steel pipe, steel welding fittings, and welded joints.

3.2 VALVE APPLICATIONS

- A. Appliance Shutoff Valves for Pressure 6"–14" w.c.: Appliance connector valve or gas stop.
- B. Piping Line Valves, NPS 2 and Smaller: Gas valve.
- C. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.

3.3 INSTALLATION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements and piping joint construction.
- B. Install regulator assemblies aboveground. Include gas valve or plug valve for each assembly.
 1. Install gas valve or plug valve and strainer upstream from each service pressure regulator.
 2. Install service pressure regulators with vent outlet turned down and with corrosion-resistant-metal insect screen.
- C. Service Entrance Piping: Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.
 1. Exterior service meter will be provided by gas utility.
 2. Install strainer upstream from each earthquake valve. Refer to Division 15 Section "Plumbing Specialties" for strainers.
- D. Concealed Locations:
 1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
 2. In Partitions: Protect tubing from physical damage when installed inside partitions or hollow walls.
 3. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in masonry walls, subject to approval of authorities having jurisdiction.
 4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, chimneys or gas vents (flues), ventilating ducts, or elevator shafts.
- E. 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.
- F. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings and in floor channels, unless indicated to be exposed to view.
- 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 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.
- K. Install strainer on inlet of each automatic and electrically operated valve.
- L. 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.

3.4 HANGERS AND SUPPORTS

- A. Refer to Division 15 Section "Hangers and Supports" for pipe hanger and support devices.

3.5 CONNECTIONS

- A. Install piping adjacent to appliances to allow service and maintenance. 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.

3.6 FIELD QUALITY CONTROL

- A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

END OF SECTION

SECTION 224500 EMERGENCY PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section specifies combination emergency shower and eyewash.

1.3 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. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- D. Tepid: Moderately warm.

1.4 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
 - 1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
 - 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. 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.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- B. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
- C. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities for plumbing fixtures for people with disabilities."

PART 2 - PRODUCTS

2.1 EMERGENCY EYEWASH WITH SHOWER

A. Plumbed Emergency Shower with Eyewash Combination Units:

1. Manufacturers: Haws 8330
2. Comparable product by one of the following:
 - a. Acorn Safety; a division of Acorn Engineering Company.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
3. Piping:
 - a. Material: Galvanized steel
 - b. Unit Supply: NPS 1-1/4.
 - c. Unit Drain: Outlet at back or side near bottom.
4. Shower:
 - a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod
 - d. Shower Head: 8-inch minimum diameter, plastic.
 - e. Mounting: Pedestal.
5. Eyewash Unit:
 - a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Plastic bowl.
 - f. Mounting: Attached shower pedestal.

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 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 emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.

- D. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."
- E. Install thermometers in supply and outlet piping connections to water-tempering equipment.
- F. Fill self-contained fixtures with flushing fluid.

3.3 CONNECTIONS

- A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."
- B. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."
- C. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

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.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports

3.5 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION

SECTION 226113
COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

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. Medical compressed-air piping, designated "medical air."
 - 2. Dental compressed-air piping, designated "dental air."
 - 3. Gas-powered-tool compressed-air piping, designated "instrument air."
 - 4. Healthcare laboratory compressed-air piping, designated "medical laboratory air."
 - 5. Compressed-air piping and specialties for nonmedical laboratory facilities, designated "laboratory air."
- B. Related Requirements:
 - 1. Section 115313 "Laboratory Fume Hoods" for compressed-air outlets in laboratory fume hoods.
 - 2. Section 123553 "Laboratory Casework" for compressed-air outlets in laboratory casework.
 - 3. Section 226119 "Compressed-Air Equipment for Laboratory Facilities" for air compressors and specialties.

1.3 DEFINITIONS

- A. Compressed-air piping systems include laboratory air and instrument air.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Seismic Qualification Certificates: For compressed-air, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Material Certificates: Signed by Installer certifying that medical compressed-air piping materials comply with require

- D. ments in NFPA 99 for positive-pressure medical gas systems.
- E. Brazing certificates.
- F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Medical Air Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.
 2. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is an NRTL, and that is acceptable to authorities having jurisdiction.
 1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.
- C. 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."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Instrument air operating at 175 psig.
- B. Laboratory air operating at 50 psig.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Compressed-air shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term "withstand" means "the manifold will remain in place without separation of any parts when subjected to the seismic forces specified."
 2. Component Importance Factor is 1.5.

2.3 PIPES, TUBES, AND FITTINGS

- A. Comply with ASME B31.9, "Building Services Piping," for laboratory air piping operating at 150 psig or less.
- B. Copper Water Tube: ASTM B 819, Type L, seamless, hard drawn temper.

- C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
- D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

2.4 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.

2.5 VALVES

A. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Allied Healthcare Products Inc.; Chemetron Division.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - d. Conbraco Industries, Inc.
 - e. NIBCO INC.
2. Standard: MSS SP-110.
3. Description: Three-piece body, brass or bronze.
4. Pressure Rating: 300 psig minimum.
5. Ball: Full-port, chrome-plated brass.
6. Seats: PTFE or TFE.
7. Handle: Lever.
8. Stem: Blowout proof with PTFE or TFE seal.
9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

B. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following] [provide products by one of the following:
 - a. Allied Healthcare Products Inc.; Chemetron Division.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - d. Conbraco Industries, Inc.
 - e. Ohio Medical Corporation.
 - f. Tri-Tech Medical Inc.
2. Description: In-line pattern, bronze.
3. Pressure Rating: 300 psig minimum.
4. Operation: Spring loaded.
5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing 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. Comply with NFPA 99 for installation of compressed-air piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install compressed-air piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- I. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. 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.
- K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and for branch connections.
- O. Install laboratory air piping to air service connections specified in this Section, to medical air service connections in equipment specified in Section 226313 "Gas Piping for Laboratory Facilities," and to equipment specified in other Sections requiring medical air service.
- P. Piping Restraint Installation: Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- Q. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- R. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
- S. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.

- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install pressure regulators on compressed-air piping where reduced pressure is required.

3.3 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.
- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- D. Flanged Joints: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
- E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or Type 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet : MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within 12 inches of each fitting and coupling.

- H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch- minimum rods.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 2. NPS 3/4: 84 inches with 3/8-inch rod.
 3. NPS 1 : 96 inches with 3/8-inch rod.
 4. NPS 1-1/4 : 108 inches with 3/8-inch rod.
 5. NPS 1-1/2 : 10 feet with 3/8-inch rod.
 6. NPS 2 : 11 feet with 3/8-inch rod.
- J. Install supports for vertical copper tubing every 10 feet .

3.5 IDENTIFICATION

- A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 1. Laboratory Air: Black letters on yellow-and-white checkerboard background.
 2. Instrument Air: White letters on red background.

3.6 FIELD QUALITY CONTROL FOR COMPRESSED-AIR PIPING IN NONMEDICAL LABORATORY FACILITIES

- A. Testing Agency: Engage qualified testing agency to perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and to prepare test and inspection reports.
- B. Tests and Inspections:
 1. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill compressed-air piping with oil-free dry 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.
 2. Repair leaks and retest until no leaks exist.
 3. Inspect filters and pressure regulators for proper operation.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.7 PROTECTION

- A. Protect tubing from damage.
- B. Retain sealing plugs in tubing, fittings, and specialties until installation.
- C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.8 PIPING SCHEDULE

- A. Laboratory Air Piping: Type L, copper tube; wrought-copper fittings; and brazed joints.

3.9 VALVE SCHEDULE

- A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

END OF SECTION

**SECTION 226213
VACUUM PIPING FOR LABORATORY FACILITIES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Laboratory high-vacuum piping, designated "laboratory low vacuum."
- B. Related Requirements:
 - 1. Section 115313 "Laboratory Fume Hoods" for vacuum inlets in laboratory fume hoods.
 - 2. Section 123553 "Laboratory Casework" for vacuum inlets in laboratory casework.

1.3 DEFINITIONS

- A. Nonmedical laboratory vacuum piping systems include laboratory high-vacuum piping systems.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Material Certificates: Signed by Installer certifying that medical vacuum piping materials comply with requirements in NFPA 99.
- C. Brazing certificates.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Laboratory Vacuum Piping Systems for Laboratory Facilities: According to ASSE Standard #6010 for medical-gas-system installers.
 - 2. Pressure-Seal Joining Procedure for Copper Tubing: An authorized representative who is trained and approved by manufacturer.

3. Extruded-Tee Outlet Procedure: An authorized representative who is trained and approved by manufacturer.
 4. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is an NRTL, and that is acceptable to authorities having jurisdiction.
1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.
- C. 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."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Laboratory vacuum operating at 24-29 in. Hg.

2.2 PIPES, TUBES, AND FITTINGS

- A. Comply with ASME B31.9, "Building Services Piping," for laboratory air piping operating at 150 psig or less.
- B. Copper Water Tube: ASTM B 819, Type L, seamless, hard drawn temper.
- C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
- D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

2.3 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- C. Threaded-Joint Tape: PTFE.

2.4 VALVES

- A. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Allied Healthcare Products Inc.; Chemetron Division.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - d. Conbraco Industries, Inc.
 - e. NIBCO INC.

2. Standard: MSS SP-110.
3. Description: Three-piece body, brass or bronze.
4. Pressure Rating: 300 psig minimum.
5. Ball: Full-port, chrome-plated brass.
6. Seats: PTFE or TFE.
7. Handle: Lever.
8. Stem: Blowout proof with PTFE or TFE seal.
9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

B. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Allied Healthcare Products Inc.; Chemetron Division.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - d. Conbraco Industries, Inc.
2. Description: In-line pattern, bronze.
3. Pressure Rating: 300 psig minimum.
4. Operation: Spring loaded.
5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, vacuum producer sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Comply with NFPA 99 for installation of vacuum piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install vacuum piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

- J. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install piping to permit valve servicing.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
- N. Piping Restraint Installation: Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- O. Install laboratory vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- P. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
- Q. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.
- R. Install unions in copper vacuum tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 VALVE INSTALLATION

- A. Install valve boxes recessed in wall or ceiling and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Apply appropriate tape to external pipe threads.
- E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" chapter. Do not use flux. Continuously purge joint with oil-free dry nitrogen during brazing.
- F. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or Type 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet : MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within 12 inches of each fitting and coupling.
- H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch- minimum rods.
- I. 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.

3.5 IDENTIFICATION

- A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Laboratory Vacuum: Black boxed letters on white-and-black checkerboard background.

3.6 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

- A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of vacuum piping in nonmedical laboratory facilities and to prepare test and inspection reports.
- B. Tests and Inspections:

1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. 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. Test Pressure for Copper Tubing: 150 psig.
 2. Repair leaks and retest until no leaks exist.
 3. Inspect filters for proper operation.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.7 PROTECTION

- A. Protect tubing from damage.
- B. Retain sealing plugs in tubing, fittings, and specialties until installation.
- C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.8 PIPING SCHEDULE

- A. Laboratory Vacuum Piping: Type L, copper tube; wrought-copper fittings; and brazed joints.

3.9 VALVE SCHEDULE

- A. Shutoff Valves:
 1. Copper Tubing: Copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.
 2. PVC Piping:
 - a. NPS 4 and Smaller: Copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

END OF SECTION

SECTION 226313 GAS PIPING FOR LABORATORY FACILITIES

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. Carbon dioxide piping, designated "medical carbon dioxide."
 - 2. Helium piping, designated "medical helium."
 - 3. Nitrogen piping, designated "medical nitrogen."
 - 4. Nitrous oxide piping, designated "medical nitrous oxide."
 - 5. Oxygen piping, designated "medical oxygen."
- B. Related Requirements:
 - 1. Section 115313 "Laboratory Fume Hoods" for gas outlets in laboratory fume hoods.
 - 2. Section 123553 "Laboratory Casework" for gas outlets in casework.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. Specialty gas piping systems include carbon dioxide, helium, nitrogen, nitrous oxide, and oxygen for laboratory facility.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Seismic Qualification Certificates: For gas manifolds, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Material Certificates: Signed by Installer certifying that medical gas piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.

- D. Brazing certificates.
- E. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.
- F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For specialty gas piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Laboratory Gas Piping Systems for laboratory Facilities: According to ASSE Standard #6010 for medical-gas-system installers.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.
- C. 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."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Carbon dioxide operating at 50 to 55 psig.
- B. Helium operating at 50 to 55 psig.
- C. Nitrogen operating at 160 to 185 psig.
- D. Nitrous oxide operating at 50 to 55 psig.
- E. Oxygen operating at 50 to 55 psig.

2.2 PIPES, TUBES, AND FITTINGS

- A. Comply with ASME B31.9, "Building Services Piping," for laboratory air piping operating at 150 psig or less.
- B. Copper Water Tube: ASTM B 819, Type L, seamless, hard drawn temper.
- C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
- D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

2.3 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.

2.4 VALVES

A. Ball Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Allied Healthcare Products Inc.; Chemetron Division.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - d. Conbraco Industries, Inc.
 - e. NIBCO INC.
 - f. Ohio Medical Corporation.
- 2. Standard: MSS SP-110.
- 3. Description: Three-piece body, brass or bronze.
- 4. Pressure Rating: 300 psig minimum.
- 5. Ball: Full-port, chrome-plated brass.
- 6. Seats: PTFE or TFE.
- 7. Handle: Lever.
- 8. Stem: Blowout proof with PTFE or TFE seal.
- 9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

B. Check Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Allied Healthcare Products Inc.; Chemetron Division.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - d. Conbraco Industries, Inc.
 - e. Ohio Medical Corporation.
- 2. Description: In-line pattern, bronze.
- 3. Pressure Rating: 300 psig minimum.
- 4. Operation: Spring loaded.
- 5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Safety Valves:

- 1. Bronze body.
- 2. ASME-construction, poppet, pressure-relief type.
- 3. Settings to match system requirements.

D. Pressure Regulators:

- 1. Bronze body and trim.
- 2. Spring-loaded, diaphragm-operated, relieving type.
- 3. Manual pressure-setting adjustment.
- 4. Rated for 250-psig minimum inlet pressure.

5. Capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.5 SIMPLEX SPECIALTY GAS MANIFOLDS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Airgas, Inc.
 2. Air Liquide America Specialty Gases LLC.
 3. Air Products and Chemicals, Inc.
 4. BeaconMedaes.
 5. Matheson Tri-Gas.
 6. Praxair Technology, Inc.
 7. Spectra Gases, Inc.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Control-Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm-system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.
- D. Manifold and Header: Nonferrous-metal header for number of cylinders indicated. Units include design for 2000-psig minimum inlet pressure, cylinder-bank header with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
- E. Mounting: Wall with mounting brackets for manifold control cabinet and header.
- F. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.
- G. Specialty gas Manifold: For one cylinder and 55-psig line pressure, with electric heater or orifice design that will prevent freezing during high demand.
- H. Specialty Gas Cylinders: Furnished by Owner.

2.6 GAS CYLINDER STORAGE RACKS

- A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
- B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements 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. Comply with NFPA 99 for installation of medical gas piping.

- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and for branch connections.
- K. Install gas piping to laboratory gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.
- L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.
- M. Piping Restraint Installation: Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- N. Install gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- O. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
- P. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 VALVE INSTALLATION

- A. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- B. Install pressure regulators on gas piping where reduced pressure is required.

3.3 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.
- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

3.4 GAS SERVICE COMPONENT INSTALLATION

- A. Assemble patient-service console with service connections. Install with supplies concealed in walls. Attach console box or mounting bracket to substrate.
- B. Install nitrogen pressure-control panels in walls. Attach to substrate.
- C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- D. Assemble ceiling-hose assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- E. Install gas manifolds anchored to substrate.
- F. Install gas cylinders and connect to manifold piping.
- G. Install gas manifolds with seismic restraints.
- H. Install bulk gas storage tanks and reserve supply tanks with seismic restraints.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or Type 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet : MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within 12 inches of each fitting and coupling.

- H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch- minimum rods.
- 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.

3.6 IDENTIFICATION

- A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Carbon Dioxide: Black or white letters on gray background.
 - 2. Helium: White letters on brown background.
 - 3. Nitrogen: White letters on black background.
 - 4. Nitrous Oxide: White letters on blue background.
 - 5. Oxygen: White letters on green background or green letters on white background.

3.7 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry 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.
 - 2. Repair leaks and retest until no leaks exist.
 - 3. Inspect specialty gas regulators for proper operation.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- D. Prepare test and inspection reports.

3.8 PROTECTION

- A. Protect tubing from damage.
- B. Retain sealing plugs in tubing, fittings, and specialties until installation.
- C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain bulk gas storage tanks.

3.10 PIPING SCHEDULE

- A. Connect new tubing to existing tubing with memory-metal couplings.
- B. Specialty Gas Piping: Type L, copper tube; wrought-copper fittings; and brazed joints.

3.11 VALVE SCHEDULE

- A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

END OF SECTION

SECTION 230020 MECHANICAL DEMOLITION

1. PART 1 GENERAL

1.1 DESCRIPTION

- A. This section specifies the demolition and removal of diffusers, ductwork, ductwork insulation, piping, piping insulation, and accessories in existing building.

2. PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual Sections.

3. PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and existing ductwork and piping arrangements are as shown on Drawings.
- B. Demolition drawings are based on casual field observation and existing record documents. The demolition Drawings are diagrammatic and show the general scope of demolition work and do not show all the construction detail of the original record drawings. Report discrepancies to the University before disturbing existing installation.
- C. The Contractor shall visit the existing building and grounds and review the existing building record drawings for details of existing installation to familiarize himself with existing conditions prior to submitting bid. No allowance will be made subsequently, in this connection, on behalf of the Contractor for any error or negligence on his part.
- D. Beginning of demolition means the Contractor accepts existing conditions.

3.2 PREPARATION

- A. Disconnect mechanical systems in areas scheduled for removal. Notify the University of areas to be affected by mechanical demolition work prior to commencing.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

- A. Demolish and remove from site, and extend existing mechanical work under provisions of this Division and as indicated on the Drawings unless otherwise noted.
- B. Unless otherwise noted on the Drawings, all salvage items removed in connection with this Contract are to become the property of the Contractor. Salvage items noted to remain the property of the University shall be delivered to a location to be designated by the University. Contractor shall remove from construction areas all trash or debris as it accumulates and dispose of it off campus at no additional cost to the University. All construction areas shall be kept clean, safe, and orderly at all times. At the completion and acceptance for work, Contractor shall remove from the site all debris and surplus materials resulting from this Work and dispose of them off campus at no additional cost to the University.

- C. Remove, relocate, and extend existing installations to accommodate new construction as required for proper installation and system operation.
- D. Remove all accessories above grade. Cut piping flush with walls and floors, and patch surfaces.
- E. Seal all existing roof penetrations which will not be reused. Seal all new roof penetrations air and water tight.
- F. Remove, relocate or provide brackets, hangers, and other accessories as required.
- G. Repair adjacent construction and finishes damaged during demolition and extension work.
- H. Maintain access to existing mechanical installations which remain active.
- I. The Contractor shall remove diffusers, ductwork, and their appurtenances no longer required unless otherwise noted.
- J. The Contractor shall remove all insulation from existing ductwork to remain if required to perform the new work.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be returned to the University.
- B. All building surfaces damaged and openings left by new Work or the removal or relocation of mechanical equipment, piping, etc., shall be repaired to original condition and painted by the Contractor.
- C. All ductwork and piping identified as remaining shall be reinsulated with duct wrap wherever the insulation was required to be disturbed to perform the work.

END OF SECTION

SECTION 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. 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.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers:
 - 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. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. 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.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 230517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel, plastic or Stainless steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide **1-inch** annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.2 SLEEVE AND SLEEVE-SEAL SCHEDULE

- 1. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves or PVC-pipe sleeves.
- 2. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves or PVC-pipe sleeves.

END OF SECTION

SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
 - 2. Iron, single-flange butterfly valves.
 - 3. Bronze gate valves.
 - 4. Iron gate valves.
 - 5. Bronze globe valves.
 - 6. Iron globe valves.

- B. Related Sections:
 - 1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

- B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

- B. Valve Sizes: Same as upstream piping unless otherwise indicated.

- C. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 and smaller.

- D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

3. Butterfly Valves: With extended neck.

E. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE BALL VALVES

1. Manufacturers:
 - a. Nibco, Inc., Model T-595-Y-66 or approved equivalent.
 - b. Watts Regulator Co.
 - c. Hammond Valve Co.
2. MSS SP110, bronze, three piece body (ASTM B584 or ASTM B52) valve with stainless steel full-port ball and stem (ASTM A276). Furnish with Teflon packing and ball seats and fluorocarbon rubber O-ring seals. Body nuts and bolts shall be zinc dichromate plated steel (ASTM A449). Valve may be furnished with threaded or solder end connections. Insulated valves shall have Nibco NIB-SEAL (no known equal) insulated extended handle and shall include a vapor seal, adjustable memory stop and valve packing maintenance without disturbing the insulation.
3. Rating: 150 lb.-S.W.P. 600 lb.-W.O.G.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers:
 - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. Bray Controls; a division of Bray International.
 - c. Conbraco Industries, Inc.; Apollo Valves.
 - d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - e. Crane Co.; Crane Valve Group; Jenkins Valves.
 - f. Crane Co.; Crane Valve Group; Stockham Division.
 - g. DeZurik Water Controls.
 - h. Hammond Valve.
 - i. Kitz Corporation.
 - j. Milwaukee Valve Company.
 - k. NIBCO INC.
 - l. Norriseal; a Dover Corporation company.
 - m. Red-White Valve Corporation.
 - n. Spence Strainers International; a division of CIRCOR International.
 - o. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

B. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:

1. Manufacturers:

- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. Bray Controls; a division of Bray International.
- c. Conbraco Industries, Inc.; Apollo Valves.
- d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- e. Crane Co.; Crane Valve Group; Jenkins Valves.
- f. Crane Co.; Crane Valve Group; Stockham Division.
- g. DeZurik Water Controls.
- h. Hammond Valve.
- i. Kitz Corporation.
- j. Milwaukee Valve Company.
- k. NIBCO INC.
- l. Norriseal; a Dover Corporation company.
- m. Red-White Valve Corporation.
- n. Spence Strainers International; a division of CIRCOR International.
- o. Tyco Valves & Controls; a unit of Tyco Flow Control.
- p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 150 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: NBR.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

C. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

1. Manufacturers:

- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. Bray Controls; a division of Bray International.
- c. Conbraco Industries, Inc.; Apollo Valves.
- d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- e. Crane Co.; Crane Valve Group; Center Line.
- f. Crane Co.; Crane Valve Group; Stockham Division.
- g. DeZurik Water Controls.
- h. Hammond Valve.
- i. Kitz Corporation.
- j. Milwaukee Valve Company.
- k. Mueller Steam Specialty; a division of SPX Corporation.
- l. NIBCO INC.
- m. Norriseal; a Dover Corporation company.
- n. Spence Strainers International; a division of CIRCOR International.
- o. Sure Flow Equipment Inc.
- p. Tyco Valves & Controls; a unit of Tyco Flow Control.

q. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 150 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Nickel-plated ductile iron.

D. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:

1. Manufacturers:

- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. Bray Controls; a division of Bray International.
- c. Conbraco Industries, Inc.; Apollo Valves.
- d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- e. Crane Co.; Crane Valve Group; Center Line.
- f. Crane Co.; Crane Valve Group; Stockham Division.
- g. DeZurik Water Controls.
- h. Hammond Valve.
- i. Kitz Corporation.
- j. Milwaukee Valve Company.
- k. Mueller Steam Specialty; a division of SPX Corporation.
- l. NIBCO INC.
- m. Norriseal; a Dover Corporation company.
- n. Spence Strainers International; a division of CIRCOR International.
- o. Sure Flow Equipment Inc.
- p. Tyco Valves & Controls; a unit of Tyco Flow Control.
- q. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 150 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: NBR.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Nickel-plated ductile iron.

E. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers:

- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. Conbraco Industries, Inc.; Apollo Valves.
- c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- d. Crane Co.; Crane Valve Group; Jenkins Valves.
- e. Crane Co.; Crane Valve Group; Stockham Division.
- f. DeZurik Water Controls.
- g. Flo Fab Inc.

- h. Hammond Valve.
- i. Kitz Corporation.
- j. Legend Valve.
- k. Milwaukee Valve Company.
- l. NIBCO INC.
- m. Norriseal; a Dover Corporation company.
- n. Red-White Valve Corporation.
- o. Spence Strainers International; a division of CIRCOR International.
- p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

F. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

1. Manufacturers:

- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. American Valve, Inc.
- c. Conbraco Industries, Inc.; Apollo Valves.
- d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- e. Crane Co.; Crane Valve Group; Center Line.
- f. Crane Co.; Crane Valve Group; Stockham Division.
- g. DeZurik Water Controls.
- h. Flo Fab Inc.
- i. Hammond Valve.
- j. Kitz Corporation.
- k. Legend Valve.
- l. Milwaukee Valve Company.
- m. Mueller Steam Specialty; a division of SPX Corporation.
- n. NIBCO INC.
- o. Norriseal; a Dover Corporation company.
- p. Spence Strainers International; a division of CIRCOR International.
- q. Sure Flow Equipment Inc.
- r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Nickel-plated ductile iron.

2.4 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers:

- a. American Valve, Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Jenkins Valves.
- d. Crane Co.; Crane Valve Group; Stockham Division.
- e. Hammond Valve.
- f. Kitz Corporation.
- g. Milwaukee Valve Company.
- h. NIBCO INC.
- i. Powell Valves.
- j. Red-White Valve Corporation.
- k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- l. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded **or solder joint**.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron].

B. Class 125, RS Bronze Gate Valves:

1. Manufacturers

- a. American Valve, Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Jenkins Valves.
- d. Crane Co.; Crane Valve Group; Stockham Division.
- e. Hammond Valve.
- f. Kitz Corporation.
- g. Milwaukee Valve Company.
- h. NIBCO INC.
- i. Powell Valves.
- j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- k. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded **or solder joint**.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

C. Class 150, NRS Bronze Gate Valves:

1. Manufacturers:

- a. Hammond Valve.
- b. Kitz Corporation.
- c. Milwaukee Valve Company.
- d. NIBCO INC.
- e. Powell Valves.
- f. Red-White Valve Corporation.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 300 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

D. Class 150, RS Bronze Gate Valves:

1. Manufacturers: :

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Stockham Division.
- c. Hammond Valve.
- d. Kitz Corporation.
- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Powell Valves.
- h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- i. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 300 psig .
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

2.5 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: :

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Stockham Division.
- c. Hammond Valve.

- d. Kitz Corporation.
- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Powell Valves.
- h. Red-White Valve Corporation.
- i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- j. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded **or solder joint**].
- e. Stem and Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron.

B. Class 125, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Stockham Division.
- c. NIBCO INC.
- d. Red-White Valve Corporation.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded **or solder joint**.
- e. Stem: Bronze.
- f. Disc: PTFE or TFE.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

C. Class 150, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Hammond Valve.
- c. Kitz Corporation.
- d. Milwaukee Valve Company.
- e. NIBCO INC.
- f. Powell Valves.
- g. Red-White Valve Corporation.
- h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- i. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 300 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.

- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: PTFE or TFE.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball or butterfly valves.
 - 2. Throttling Service, Except Steam: **Ball, or butterfly**] valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
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 except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Three piece, full port, bronze with stainless-steel trim. Rating: 150 lb.-S.W.P., 600 lb.-W.O.G
3. Bronze Gate Valves: Class 150, NRS.
4. Bronze Globe Valves: Class 150, nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, stainless-steel disc.
4. Iron Gate Valves: Class 250, NRS.
5. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 250.

END OF SECTION

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Metal pipe hangers and supports.
 2. Trapeze pipe hangers.
 3. Thermal-hanger shield inserts.
 4. Fastener systems.
 5. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses.
1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment **and obtain approval from authorities having jurisdiction.**

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: **Signed and sealed by a qualified professional engineer.** Show fabrication and installation details and include calculations for the following; include Product Data for components:
1. Trapeze pipe hangers.
 2. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of **carbon steel**.
- B. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, **zinc-coated** or **stainless-** steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-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 INSTALLATION

- A. Metal 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 the building structure.
- B. Metal 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 for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.

- I. 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.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 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 bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 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/D1.1M 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 so contours of welded surfaces match adjacent contours.

3.4 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.

3.5 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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Clean and touchup 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.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. 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.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.

1.2 ACTION SUBMITTAL

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: 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.
 - 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: White.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 in.,, 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.
 - 7. Fasteners: Stainless-steel [rivets] [rivets or self-tapping screws] [self-tapping screws].
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 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.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to [partially cover] [cover full] circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch** thick, and having predrilled holes for attachment hardware.
- B. Letter Color: **Black**.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 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.
- G. Fasteners: Stainless-steel **rivets or self-tapping screws**
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet 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 labels.
- B. Pipe Label Color Schedule:
 - 1. Heating Water Piping:
 - a. Background Color: To match existing labeling.
 - b. Letter Color: To match existing labeling.
 - 2. Refrigerant Piping:
 - a. Background Color: Blue.
 - b. Letter Color: Black.

3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue: For cold-air supply ducts.
 - 2. Yellow: For hot-air supply ducts.
 - 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 - 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Locate labels 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; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
 - a. Refrigerant: 1-1/2 inches.
 - b. Hot Water: 1-1/2 inches
 2. Valve-Tag Color:
 - a.
 - b. Refrigerant: Natural
 - c. Hot Water: Natural
 3. Letter Color:
 - a. Refrigerant: Black
 - b. Hot Water: Black

END OF SECTION

SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pre-Reading Existing Air Systems Before Start of Construction:
 - a. Read and record all existing air inlets and outlets serving Ground Floor of Wing B and all of Wing C.
 - b. Read and record all existing air handling systems serving Wing C (AHU-6 and all associated return fans).
 - c. Read and record all existing exhaust fans serving Wing C.
2. Post Reading and Balancing Air Systems:
 - a. Readjust, rebalance and re-read and record all existing and new air inlets and outlets in Wing C.
 - b. Readjust, rebalance, and re-read and record all existing and new air inlets and outlets on the Ground Floor of Wing B.
 - c. Adjust or replace sheaves and belts and provide the final cfm called for on AHU-6, the existing air handling unit serving Wing C (including associated return fan).
 - d. Adjust or replace sheaves and belts on existing exhaust fans EF4C and EF5C and provide new air quantities.
 - e. Read and record all exhaust fans serving Wing C.
3. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.3 INFORMATIONAL SUBMITTALS

- A. Strategies and Procedures Plan: Within **30** days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- B. Certified TAB reports.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC.
 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC.
- B. Certify TAB field data reports and perform the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB contractor's forms approved by Owner's Representative.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as reheat coils and venturi valves, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 1. Permanent electrical-power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in **AABC's "National Standards for Total System Balance"** and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," Section 230719 "HVAC Piping Insulation."

- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in **inch-pound (IP)** units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 6. Obtain approval from **Owner** for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. **Compensating for Diversity:** When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. **Pressure-Independent, Variable-Air-Volume Systems:** After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.
 2. Check liquid level in expansion tank.
 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated presettings.
- E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
1. Entering- and leaving-water temperature.
 2. Water flow rate.
 3. Water pressure drop.
 4. Dry-bulb temperature of entering and leaving air.
 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 6. Airflow.
 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
 2. Airflow.
 3. Entering- and leaving-air temperature at full load.
 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 5. Calculated kilowatt at full load.
 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.
 4. Air pressure drop.
 5. Refrigerant suction pressure and temperature.

3.12 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
1. Measure and record the operating speed, airflow, and static pressure of each fan.
 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 3. Check the refrigerant charge.
 4. Check the condition of filters.
 5. Check the condition of coils.
 6. Check the operation of the drain pan and condensate-drain trap.

7. Check bearings and other lubricated parts for proper lubrication.
 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 4. Balance each air outlet.

3.13 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.
 3. Heating-Water Flow Rate: Plus or minus 10 percent..
 4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.14 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare **biweekly** progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.15 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Settings for supply-air, static-pressure controller.
 - g. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.

3.16 Equipment Requiring Testing, Adjusting and Balancing:

Equipment	Air Balance	Hydronic Balance
Existing and new reheat coils Wings B and C		X
Existing air handling unit AH-6, including associated return fan	X	X
Existing exhaust fans EF-4C and EF-5C and all other existing exhaust fans Wing C.	X	
Existing and new venturi valves for supply and exhaust, Wings B and C	X	
Existing and new air inlets and outlets, Wing B ground floor and Wing C all.	X	
New split system fan coil unit	X	
Existing and new lab hoods, Wing C	X	

END OF SECTION

SECTION 230713 DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
 - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

- B. Related Sections:
 - 1. Section 230716 "HVAC Equipment Insulation."
 - 2. Section 230719 "HVAC Piping Insulation."
 - 3. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

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

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing 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.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR All-Service Duct Wrap.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.

- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - d. Mon-Eco Industries, Inc.; 22-25.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
- 1. Products:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
- 1. Products:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, 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, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
- 1. Products:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
 - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F
 - 4. Solids Content: 60 percent by volume and 66 percent by weight.
 - 5. Color: White.

2.4 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
- 1. Products:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
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 and PVC Jacket Flashing Sealants:
1. Products:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of 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.

2.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.
1. Products:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.

2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: **White**
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
1. Products:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
 2. Finish and thickness are indicated in field-applied jacket schedules.
 3. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 4. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
- E. Self-Adhesive Outdoor Jacket: 60-mil- thick, 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 white stucco-embossed aluminum-foil facing.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Polyguard Products, Inc.; Alumaguard 60.

2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches
 3. Thickness: 11.5 mils
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inchn width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products:
 - a. ABI, Ideal Tape Division; 488 AWF.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - c. Compac Corporation; 120.
 - d. Venture Tape; 3520 CW.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
1. Products:

- a. ITW Insulation Systems; Gerrard Strapping and Seals.
- b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

B. Insulation Pins and Hangers:

1. 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:
 - 1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inchthick 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.
2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened 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:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inchthick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Self-Sticking-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:
 - 1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
 - 2) GEMCO; Peel & Press.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: [Copper- or zinc-coated, low-carbon steel] [Aluminum] [Stainless steel], fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.

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:
 - 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.
5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy.
 1. Manufacturers:
 - a. C & F Wire.

2.10 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- 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.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. 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. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **2 inches** o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. 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.

3.3 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: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for **100** percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one 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 two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. 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.

- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.6 FINISHES

- A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 1. Flat Acrylic Finish: **Two** finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Owner's representative, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
 - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
- B. Items Not Insulated:
 - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums and casings.
 - 4. Flexible connectors.
 - 5. Vibration-control devices.
 - 6. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, thickness and density shall be according to California Energy Code Requirements.
- B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, thickness and density shall be according to California Energy Code Requirements
- C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, thickness and density shall be according to California Energy Code Requirements.
- D. Exposed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, thickness and density shall be according to California Energy Code Requirements.
- E. Exposed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, thickness and density shall be according to California Energy Code Requirements.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
 - 1. PVC: 20 mils thick.
- D. Ducts and Plenums, Exposed:
 - 1. PVC 20 mils thick.
 - 2. Aluminum, 0.016 inch thick.

END OF SECTION

SECTION 230719 HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Heating hot-water piping, indoors and outdoors.
 - 2. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
 - 1. Section 230713 "Duct Insulation."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing 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.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- 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. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products:
 - a. Pittsburgh Corning Corporation; Foamglas.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 6. Preformed Pipe Insulation with Factory-Applied [**ASJ**] [**ASJ-SSL**]: Comply with ASTM C 552, Type II, Class 2.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armocell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1290, Type I.
 - 1. Products:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR All-Service Duct Wrap.
- H. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000-Degree Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, [**without factory-applied jacket**] [**with factory-applied**]

ASJ] [with factory-applied ASJ-SSL]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products: =

- a. Armacell LLC; Tubolit.
- b. Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products:

- a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Products:

- a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products:

- a. Aeroflex USA, Inc.; Aero seal.
- b. Armacell LLC; Armaflex 520 Adhesive.
- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
- d. K-Flex USA; R-373 Contact Adhesive.

- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
- b. Eagle Bridges - Marathon Industries; 225.
- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
- d. Mon-Eco Industries, Inc.; 22-25.

- E. 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:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - d. Mon-Eco Industries, Inc.; 22-25.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.

2.4 MASTICS

A. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96/E 96M, 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, 58 percent by volume and 70 percent by weight.
5. Color: White.

B. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 100 to plus 300 deg F.
 5. Color: White or gray.
- B. FSK and Metal Jacket Flashing Sealants:
1. Products:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: Aluminum.
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of 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.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with

a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

a. Products:

- 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

a. Products:

- 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- 2) **<Insert manufacturer's name; product name or designation>.**

7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

a. Products:

- 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

1. Products:

- a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
- b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products:

- a. Johns Manville; Zeston.
- b. P.I.C. Plastics, Inc.; FG Series.
- c. Proto Corporation; LoSmoke.

- d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: **White.**
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
- 1. Products:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
 - 2. Finish and thickness are indicated in field-applied jacket schedules.
 - 3. Moisture Barrier for Indoor Applications: **1-mil- thick, heat-bonded polyethylene and kraft paper**].
 - 4. Moisture Barrier for Outdoor Applications: **3-mil- thick, heat-bonded polyethylene and kraft paper.**
 - 5. Factory-Fabricated Fitting Covers:
 - a. Same material, finish, and thickness as jacket.
 - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - c. Tee covers.
 - d. Flange and union covers.
 - e. End caps.
 - f. Beveled collars.
 - g. Valve covers.
 - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket: 60-mil- thick, 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 **[white] [stucco-embossed]** aluminum-foil facing.
- 1. Products:
 - a. Polyguard Products, Inc.; Alumaguard 60.
 - b. Or equal
- F. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
- 1. Products:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film.
 - b. Or equal.

- G. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
1. Products:
 - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Film.
 - b. Or equal.
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
1. Products:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - b. Or equal.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products:
 - a. ABI, Ideal Tape Division; 488 AWF.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - c. Compac Corporation; 120.
 - d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
 - b. Or equal.
2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products:
 - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
 - b. Or equal.
2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.10 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, **1/2 inch** wide with **wing seal or closed seal**.

1. Products:
 - a. ITW Insulation Systems: Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: **0.080-inch nickel-copper alloy.**
 1. Manufacturers:
 - a. C & F Wire.
 - b. Or equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **4 inches** o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches 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.

3.3 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 Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe

- diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of 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 services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. 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.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- 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 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

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. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube 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 polyolefin 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 polyolefin 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 cut sections of polyolefin pipe and sheet insulation to valve body.
2. 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.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch 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.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

- A. Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 1. Flat Acrylic Finish: **Two** finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Owner's representative, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to **three** locations of straight pipe, **three** locations of threaded fittings, **three** locations of welded fittings, **two** locations of threaded strainers, **two** locations of welded strainers, **three** locations of threaded valves, and **three** locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

- A. Heating-Hot-Water Supply and Return, 200 Deg F and Below: Insulation shall be one of the following (Thickness and density to comply with California Energy Code):
 - 1. Cellular Glass
 - 2. Mineral-Fiber, Preformed Pipe, Type I
- B. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric, 1 inch thick.
- C. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric 1 inch thick.
 - 1. Cellular Glass: 1-1/2 inches thick.
 - 2. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Heating-Hot-Water Supply and Return, 200 Deg F and Below: Insulation shall be one of the following (Thickness and density to comply with California Energy Code):
 - 1. Cellular Glass
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I
- B. Refrigerant Suction and Hot-Gas Piping: Insulation shall be[one of] the following:
 - 1. Cellular Glass: 2 inches thick.
 - 2. Flexible Elastomeric: 2 inches thick.
- C. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be[one of] the following:
 - 1. Flexible Elastomeric: 2 inches thick.

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. PVC: 20 mils thick.
- D. Piping, Exposed:
 - 1. PVC: 20 mils thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. PVC: 20 mils thick.
- D. Piping, Exposed:
 - 1. PVC: 20 mils thick.
 - 2. Aluminum, 0.016 inch thick.

END OF SECTION

SECTION 230900 INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 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.

1.2 ACTION SUBMITTALS

- A. Product Data: For each control device indicated.
- B. Shop Drawings:
 - 1. Schematic flow diagrams.
 - 2. Power, signal, and control wiring diagrams.
 - 3. Details of control panel faces.
 - 4. Damper schedule.
 - 5. Valve schedule.
 - 6. DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
 - 7. Control System Software: Schematic diagrams, written descriptions, and points list.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Software and firmware operational documentation.

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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

- A. Manufacturers:
1. Johnson Controls, Inc.; Controls Group, Metasys N2 system to match the existing system in the building.
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. The new work shall be installed to match the existing system in the Engineering and Technology Building and the new points shall be brought over to the main campus GUI in the E&T building.

2.3 DDC EQUIPMENT

- A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
- B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 3. Local operator interface provides for download from or upload to operator workstation.
- C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation[with three-position (on-off-auto) override switches and status lights.
 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA)[with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer].
 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 7. Universal I/Os: Provide software selectable binary or analog outputs.
- D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

2.4 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
 3. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.5 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

2.6 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
1. Manufacturers:

- a. Johnson Controls or equal
- 2. Accuracy: Plus or minus 0.5 deg F at calibration point.
- 3. Wire: Twisted, shielded-pair cable.
- 4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
- 5. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft..
- 6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
- 7. Room Sensor Cover Construction: Manufacturer's standard locking covers. The thermostat shall match existing building thermostats.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed
 - c. Thermometer: Concealed.
 - d. Color: to match existing in building
 - e. Orientation: to match existing in building

C. RTDs and Transmitters:

- 1. Manufacturers:
 - a. Johnson Controls
 - b. BEC Controls Corporation.
 - c. MAMAC Systems, Inc.
 - d. RDF Corporation.
- 2. Accuracy: Plus or minus 0.2 percent at calibration point.
- 3. Wire: Twisted, shielded-pair cable.
- 4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed
 - c. Thermometer: Concealed.
 - d. Color: to match existing in building
 - e. Orientation: to match existing in building

2.7 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - 1. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - 4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
 - 5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - 6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Manufacturers:
 - a. Belimo Aircontrols (USA), Inc.
 - b. Johnson Controls
 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 3. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
 4. Coupling: V-bolt and V-shaped, toothed cradle.
 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 7. Power Requirements (Two-Position Spring Return): [24] [120] [230]-V ac.
 8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 10. Temperature Rating: 40 to 104 deg F.
 11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
 12. Run Time: 12 seconds open, 5 seconds closed

2.8 CONTROL VALVES

- A. Manufacturers:
1. Johnson Controls or equal
- B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Hydronic system globe valves shall have the following characteristics:
1. NPS 2 and Smaller: Class 250 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
 2. NPS 2-1/2 and Larger: Class 250 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
 3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
 - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
 - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 5-psig maximum pressure drop at design flow rate or the following:
 - a. Two Position: Line size.
 - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
 - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
 5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- D. Terminal Unit Control Valves, Reheat Coil Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
 2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
 3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- B. Install guards on thermostats in the following locations:
 1. Entrances.
 2. Public areas.
 3. Where indicated.
- C. Install automatic dampers according to Section 233300 "Air Duct Accessories."
- D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- E. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."
- F. Install hydronic instrument wells, valves, and other accessories according to Section 232113 "Hydronic Piping."
- G. Install refrigerant instrument wells, valves, and other accessories according to Section 232300 "Refrigerant Piping."
- H. Install duct volume-control dampers according to Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."

- I. Install electronic and fiber-optic cables according to Section 271500 "Communications Horizontal Cabling."

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."
- B. Install building wire and cable according to the requirements of the California Electrical Code."
- C. Install signal and communication cable according to Section 270725 "Telecommunications Cable."
 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 2. Install exposed cable in raceway.
 3. Install concealed cable in raceway.
 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 6. Test each system for compliance with sequence of operation.
 7. Test software and hardware interlocks.
- C. DDC Verification:
 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 6. Check temperature instruments and material and length of sensing elements.
 7. Check control valves. Verify that they are in correct direction.
 8. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
 9. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Provide at least eight hours of training.
- B. Before the project can be turned over to the University, the contractor shall demonstrate to the Owner's satisfaction that all components and the entire system operates properly and according to the requirements of construction documents.

END OF SECTION

SECTION 232113 HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Hot-water heating piping.
 - 2. Air-vent piping.
 - 3. Safety-valve-inlet and -outlet piping.
- B. See Section 232123 "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.2 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
 - 1. Hot-Water Heating Piping: 100 psig> at 200 deg F .
 - 2. Air-Vent Piping: 200 deg F .
 - 3. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Plastic pipe and fittings with solvent cement.
 - 2. Pressure-seal fittings.
 - 3. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 4. Air control devices.
 - 5. Hydronic specialties.
- B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

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.

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 Fittings: ASME B16.22.
 - 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:
 - 3. Basis-of-Design Product:
 - a. Anvil International, Inc.
 - b. S. P. Fittings; a division of Star Pipe Products.
 - c. Victaulic Company.
 - 4. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
 - 5. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
- E. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.

2. End Connections: Butt welding.
3. Facings: Raised face.

G. Grooved Mechanical-Joint Fittings and Couplings:

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:
3. Basis-of-Design Product:
 - a. Anvil International, Inc.
 - b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
 - c. National Fittings, Inc.
 - d. S. P. Fittings; a division of Star Pipe Products.
 - e. Victaulic Company.
4. 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 106, Grade B 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.
5. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- F. Solvent Cements for Joining Plastic Piping:
1. CPVC Piping: ASTM F 493.
 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

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. Charlotte Pipe and Foundry Company.
 - b. IPEX Inc.
 - c. KBi.
3. CPVC and PVC one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.

B. Plastic-to-Metal Transition Unions:

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. Charlotte Pipe and Foundry Company.
 - b. IPEX Inc.
 - c. KBi.
 - d. NIBCO INC.
3. MSS SP-107, CPVC and PVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International Ltd.
 - e. Matco-Norca, Inc.
 - f. McDonald, A. Y. Mfg. Co.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - h. Wilkins; a Zurn company.
2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.6 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC."
- C. Bronze, Calibrated-Orifice, Balancing Valves:
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:
 3. Basis-of-Design Product:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - c. Flow Design Inc.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Taco.
 - g. Tour & Andersson; available through Victaulic Company.
 4. Body: Bronze, ball or plug type with calibrated orifice or venturi.
 5. Ball: Brass or stainless steel.
 6. Plug: Resin.
 7. Seat: PTFE.
 8. End Connections: Threaded or socket.
 9. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 10. Handle Style: Lever, with memory stop to retain set position.
 11. CWP Rating: Minimum 125 psig.
 12. Maximum Operating Temperature: 250 deg F.
- D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
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:
 3. Basis-of-Design Product:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - c. Flow Design Inc.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Taco.
 4. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
 5. Ball: Brass or stainless steel.
 6. Stem Seals: EPDM O-rings.
 7. Disc: Glass and carbon-filled PTFE.
 8. Seat: PTFE.

9. End Connections: Flanged or grooved.
10. Pressure Gage Connections: Integral seals for portable differential pressure meter.
11. Handle Style: Lever, with memory stop to retain set position.
12. CWP Rating: Minimum 125 psig.
13. Maximum Operating Temperature: 250 deg F.

E. Automatic Flow-Control Valves:

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:
3. Basis-of-Design Product:
 - a. Flow Design Inc.
 - b. Griswold Controls.
4. Body: Brass or ferrous metal.
5. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
6. Combination Assemblies: Include bronze or brass-alloy ball valve.
7. Identification Tag: Marked with zone identification, valve number, and flow rate.
8. Size: Same as pipe in which installed.
9. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
10. Minimum CWP Rating: 175 psig.
11. Maximum Operating Temperature: 250 deg F.

2.7 AIR CONTROL DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Amtrol, Inc.
 2. Armstrong Pumps, Inc.
 3. Bell & Gossett Domestic Pump; a division of ITT Industries.
 4. Taco.
- C. Manual Air Vents:
 1. Body: Bronze.
 2. Internal Parts: Nonferrous.
 3. Operator: Screwdriver or thumbscrew.
 4. Inlet Connection: NPS 1/2.
 5. Discharge Connection: NPS 1/8.
 6. CWP Rating: 150 psig.
 7. Maximum Operating Temperature: 225 deg F.

2.8 HYDRONIC PIPING SPECIALTIES

- A. Y-Pattern Strainers:
 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 steel pipe; Class 125, cast-iron, 150, malleable-iron, or 250, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- C. Condensate-Drain Piping: Type M or DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- D. Air-Vent Piping:
1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- E. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.2 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using **mechanically formed** 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 Section 230523 "General-Duty Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

- T. Identify piping as specified in Section 230553 "Identification for HVAC Piping and Equipment."
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. 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.
 - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. 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.
- E. 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.
- F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

- G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. 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.
- D. 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.
- E. 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.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- G. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Section 230519 "Meters and Gages for HVAC Piping."

3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 - 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 - 6. Prepare written report of testing.
- C. Perform the following before operating the system:
 - 1. Open manual valves fully.
 - 2. Inspect pumps for proper rotation.
 - 3. Set makeup pressure-reducing valves for required system pressure.
 - 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 - 5. Set temperature controls so all coils are calling for full flow.
 - 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 - 7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 232300 REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-22:
 - 1. Suction Lines for Air-Conditioning Applications: 185 psig.
 - 2. Suction Lines for Heat-Pump Applications: 325 psig.
 - 3. Hot-Gas and Liquid Lines: 325 psig.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - 3. Operator: Rising stem and hand wheel.
 - 4. Seat: Nylon.
 - 5. End Connections: Socket, union, or flanged.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 275 deg F.
- B. Packed-Angle Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze.
 - 2. Packing: Molded stem, back seating, and replaceable under pressure.
 - 3. Operator: Rising stem.
 - 4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
 - 5. Seal Cap: Forged-brass or valox hex cap.
 - 6. End Connections: Socket, union, threaded, or flanged.
 - 7. Working Pressure Rating: 500 psig.
 - 8. Maximum Operating Temperature: 275 deg F.
- C. Check Valves:
 - 1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
 - 2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
 - 3. Piston: Removable polytetrafluoroethylene seat.
 - 4. Closing Spring: Stainless steel.
 - 5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
 - 6. End Connections: Socket, union, threaded, or flanged.

7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and [24] [115] [208]-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

H. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

I. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.

2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

K. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

L. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

M. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Suction Lines NPS 1-1/2 and Smaller: for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
- B. Suction Lines NPS 4 and Smaller NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed] or soldered joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 - 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
 - 2. NPS 1-1/2 and Smaller: Copper, Type ACR drawn-temper tubing and wrought-copper fittings with soldered joints.
 - 3. NPS 2 to NPS : Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.
 - 4. NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, Type ACR drawn-temper tubing and wrought-copper fittings with soldered joints.
- G. Safety-Relief-Valve Discharge Piping:
 - 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
 - 2. NPS 1-1/2 and Smaller: Copper, Type ACR drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 3. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 4. NPS 4 Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install packed-angle valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at strainers if they are not an integral part of strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.

- F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.

- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective conduit where installed below ground.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- Q. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
1. Comply with ASME B31.5, Chapter VI.
 2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.
 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 233113 METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rectangular ducts and fittings.
 - 2. Round ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Sealants and gaskets.
 - 5. Hangers and supports.
 - 6. Seismic-restraint devices.
- B. Related Sections:
 - 1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 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 Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 - 1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
 - 2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
 - 3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.

7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. 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.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum 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. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.6 SEISMIC-RESTRAINT DEVICES

- 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. Ductmate Industries, Inc.
 3. Hilti Corp.
 4. Kinetics Noise Control.

5. Loos & Co.; Cableware Division.
 6. Mason Industries.
 7. TOLCO; a brand of NIBCO INC.
 8. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by the authority having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 - 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by the authority having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling.

Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
 1. Laboratory Exhaust Ducts from connection to hood or snorkel to fan and at fan discharge: stainless steel.
- B. Supply Ducts:
 1. Ducts Connected to reheat coils and venturi valves:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 2. Ducts Connected to Air-Handling Units and upstream of terminal devices):
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: [6.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
- C. Return Ducts:

1. General

- a. Pressure Class: Positive or negative 2-inch wg.
- b. Minimum SMACNA Seal Class: A.
- c. SMACNA Leakage Class for Rectangular: 12.
- d. SMACNA Leakage Class for Round and Flat Oval: 12.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

- a. Pressure Class: Negative 3-inch wg.
- b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
- c. SMACNA Leakage Class for Rectangular: 24.
- d. SMACNA Leakage Class for Round and Flat Oval: 24.

2. Ducts Connected up and downstream of Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:

- a. Type 316, stainless-steel sheet.
 - 1) Exposed to View: No. 4 finish.
 - 2) Concealed: No. 2B finish.
- b. Pressure Class: Positive or negative 4-inch wg.
- c. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
- d. SMACNA Leakage Class: 3.

3. Ducts Connected to Equipment Not Listed Above:

- a. Pressure Class: Positive or negative 4-inch wg.
- b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
- c. SMACNA Leakage Class for Rectangular: 24.
- d. SMACNA Leakage Class for Round and Flat Oval: 24.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

2. Stainless-Steel Ducts:

- a. Exposed to Airstream: Match duct material.
- b. Not Exposed to Airstream: Match duct material.

3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

- a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.

- b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- 3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.
- G. Branch Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 - 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.

- b. Velocity 1000 to 1500 fpm: Conical tap.
- c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

**SECTION 233300
AIR DUCT ACCESSORIES**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Combination fire smoke dampers.
 - 3. Flange connectors.
 - 4. Turning vanes.
 - 5. Duct-mounted access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.
 - 8. Duct accessory hardware.

- B. Related Requirements:
 - 1. Not Used

1.2 ACTION SUBMITTALS

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

- 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. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
 - d. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: **G90**.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 316.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. McGill AirFlow LLC.
 - e. Nailor Industries Inc.
 - f. Pottorff.
 - g. Ruskin Company.
 - h. Trox USA Inc.
 - i. Vent Products Company, Inc.
 - 2. Standard leakage rating[, **with linkage outside airstream**].
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Frame: Hat-shaped, **0.094-inch- thick, galvanized sheet steel** or **0.05-inch-thick stainless steel**.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized or Stainless-steel, 0.064 inch thick.
 - 6. Blade Axles: Galvanized steel or Stainless steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze or oil-impregnated stainless-steel sleeve.

- b. Dampers in ducts with pressure classes of **3-inch wg** or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

2.4 COMBINATION FIRE SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Ruskin Company
 2. Cesco Products; a division of Mestek, Inc.
 3. Greenheck Fan Corporation.
 4. Nailor Industries Inc.
 5. Pottorff.
- B. The vertical fire/smoke damper shall be Ruskin FDS60-3 or equal for rated mechanical shaft walls. Frame shall be a minimum of 16 gauge galvanized steel formed into a structural hat channel and shall be low profile high performance type for lowest pressure drop. The blades shall be single skin galvanized steel 14 gauge equivalent thickness. Bearings shall be stainless steel turning in an extruded hole in the frame for long life. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into blade edge and shall withstand a minimum of 450°F.

2.5 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Nexus PDQ; Division of Shilco Holdings Inc.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed], factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.6 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Elgen Manufacturing.
 4. METALAIRE, Inc.
 5. SEMCO Incorporated.
 6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: **[Single]** **[Double]** wall.

2.7 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Cesco Products; a division of Mestek, Inc.
 - 3. Ductmate Industries, Inc.
 - 4. Elgen Manufacturing.
 - 5. Flexmaster U.S.A., Inc.
 - 6. Greenheck Fan Corporation.
 - 7. McGill AirFlow LLC.
 - 8. Nailor Industries Inc.
 - 9. Pottorff.
 - 10. Ventfabrics, Inc.
 - 11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.8 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Flame Gard, Inc.
 - 3. 3M.

- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.9 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Elgen Manufacturing.
 - 4. Ventfabrics, Inc.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.

2.10 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.
- C. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- D. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.11 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install 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.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire/smoke dampers according to UL listing.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
 2. Upstream and downstream] from duct filters.
 3. At drain pans and seals.
 4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 5. Adjacent to and close enough to combination fire/smoke dampers, to reset or reinstall fusible links. Access doors for access to combination fire/smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 6. At each change in direction and at maximum 50-foot spacing.
 7. Upstream and downstream from turning vanes.
 8. Upstream or downstream from duct silencers.
 9. Control devices requiring inspection.
 10. Elsewhere as indicated.
- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
 2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- J. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- K. Install flexible connectors to connect ducts to equipment.
- L. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- M. Connect diffusers to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- N. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.
- O. Install duct test holes where required for testing and balancing purposes.

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 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.

END OF SECTION

**SECTION 233713
DIFFUSERS, REGISTERS, AND GRILLES**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Round ceiling diffusers.
 - 2. Rectangular and square ceiling diffusers.
 - 3. Perforated diffusers.
 - 4. Louver face diffusers.
 - 5. Adjustable bar registers and grilles.

- B. Related Sections:
 - 1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

- B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

- A. Rectangular and Square Ceiling Diffusers (CD, RG):
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Titus
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Hart & Cooley Inc.
 - e. Krueger.
 - f. METALAIRE, Inc.
 - g. Nailor Industries Inc.
 - h. Price Industries.
 - i. Tuttle & Bailey.
 - 2. Material: Steel.
 - 3. Finish: Baked enamel, white.
 - 4. Face Size: 24 by 24 inches or 12 by 12 inches.
 - 5. Face Style: Four cone.
 - 6. Mounting: Surface or T-bar to match ceiling type.
 - 7. Pattern: Adjustable.
 - 8. Dampers: Radial opposed blade.

B. Perforated Diffuser (CD, RG)

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following]:
 - a. Titus.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Hart & Cooley Inc.
 - e. Krueger.
 - f. METALAIRE, Inc.
 - g. Nailor Industries Inc.
 - h. Price Industries.
 - i. Tuttle & Bailey.
 - j. Warren Technology.
2. Material: Steel backpan and pattern controllers, with steel face.
3. Finish: Baked enamel, white
4. Face Size: 12 by 12 inches, 24 by 24 inches
5. Duct Inlet: Round or Square.
6. Face Style: Flush.
7. Mounting: Surface or T-bar to match ceiling type.
8. Pattern Controller: Four louvered deflector patches.
9. Dampers: Opposed blade.

2.2 REGISTERS AND GRILLES

A. Adjustable Bar Register (SD, EG):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Titus
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Hart & Cooley Inc.
 - e. Krueger.
 - f. METALAIRE, Inc.
 - g. Nailor Industries Inc.
 - h. Price Industries.
 - i. Tuttle & Bailey.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
5. Core Construction: Removable.
6. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
7. Frame: 1 inch wide.
8. Mounting: Countersunk screw.
9. Damper Type: Adjustable opposed blade
10. Accessories:
 - a. Rear-blade gang operator.

B. Adjustable Bar Grille (SD, ED)

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Carnes.
 - c. Hart & Cooley Inc.
 - d. Krueger.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Price Industries.
 - h. Titus.
 - i. Tuttle & Bailey.
3. Material: Steel.
4. Finish: Baked enamel, white.
5. Face Blade Arrangement: Horizontal 3/4 inch apart.
6. Core Construction: Removable.
7. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
8. Frame: 1 inch wide.
9. Mounting: Countersunk screw.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 238126 SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
 - 2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- C. Shop Drawings: 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.

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
 - a. For Compressor: One year(s) from date of Substantial Completion.
 - b. For Parts: One year(s) from date of Substantial Completion.
 - c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Mitsubishi
 2. Daikin
 3. SANYO North America Corporation; SANYO Fisher Company.

2.2 INDOOR UNITS (5 TONS OR LESS)

- A. Wall-Mounted, Evaporator-Fan Components:
 1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
 3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
 4. Fan: Direct drive, centrifugal.
 5. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Enclosure Type: Totally enclosed, fan cooled.
 - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - f. Mount unit-mounted disconnect switches on unit.
 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 7. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 1 inch deep.
 - b. Single-wall, stainless-steel sheet.

- c. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 - d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: NPS 1.
 - e. Pan-Top Surface Coating: Asphaltic waterproofing compound.
8. Air Filtration Section:
- a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Disposable Panel Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: 1 inch.
 - 3) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

- A. Air-Cooled, Compressor-Condenser Components:
- 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
 - 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
 - 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
 - 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 45 deg F.
 - 7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls."
- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

- C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
 - 1. Compressor time delay.
 - 2. 24-hour time control of system stop and start.
 - 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 - 4. Fan-speed selection including auto setting.
- D. Automatic-reset timer to prevent rapid cycling of compressor.
- E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- F. Drain Hose: For condensate.
- G. Additional Monitoring:
 - 1. Monitor constant and variable motor loads.
 - 2. Monitor variable-frequency-drive operation.
 - 3. Monitor economizer cycle.
 - 4. Monitor cooling load.
 - 5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounted, compressor-condenser components on 4-inch-thick, reinforced concrete base that is 4 inches larger, on each side, than unit.
- D. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
- E. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- F. Install seismic restraints.
- G. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 238216 AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes [hot-water] [and] [electric] air coils that are not an integral part of air-handling units.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.
- B. Shop Drawings: Diagram power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

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. 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 applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.1 WATER COILS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
 - 2. Aerofin Corporation.
 - 3. Carrier Corporation.
 - 4. Coil Company, LLC.
 - 5. Dunham-Bush, Inc.
 - 6. Super Radiator Coils.

7. Trane.
8. USA Coil & Air.

- C. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.
- D. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.
- E. Source Quality Control: Factory tested to 300 psig.
- F. Tubes: copper, minimum 0.049 inch thick.
- G. Fins: Aluminum, minimum 0.010 inch thick.
- H. Headers: Seamless copper tube with brazed joints, prime coated
- I. Frames: Galvanized-steel channel frame, minimum 0.0625 inch] thick for slip-in or flanged mounting.
- J. Hot-Water Coil Characteristics:
 1. Tube Diameter: 0.625 inch
 2. Coating: Baked phenolic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- C. Straighten bent fins on air coils.
- D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.
- E. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- F. Install piping adjacent to coils to allow service and maintenance.
- G. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 230900 "Instrumentation and Control for HVAC" and other piping specialties are specified in Section 232113 "Hydronic Piping."

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. Operational Test: Operate coils to confirm proper unit operation.
 2. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

SECTION 260010 ELECTRICAL GENERAL REQUIREMENTS

PART 1- GENERAL

All of the work required to be provided as described in this Division 16, Section 16010 of the specifications shall be provided by a single entity sub-contractor skilled in this specialty, holding a valid C-10 California contractor's license, and such sub-contractor shall be designated and listed in the sub-contractor listing portion of the bid form by the prime contractor when bidding this work to the Owner.

1.1 GENERAL REQUIREMENTS

The following requirements shall apply to Division 16 sections.

A. Prohibited Materials and Construction Practices:

1. Plastic conduit for interior electrical use.
2. Aluminum conduit: Consult Owner for locations where use of aluminum conduit will be permitted.
3. Aluminum conductors, cables, and bus bars.
4. Use of incompatible materials: Aluminum fittings and boxes shall not be used with steel conduit. All materials in a raceway system shall be compatible.
5. Use of set screw type conduit fittings.
6. Use of wire to support conduit, boxes.
7. Use of wood strips and wood screws to support lighting fixtures.
8. Use of Class J fuses.
9. Direct burial electrical cable.
10. Underground ducts and conduits crossing above gas piping. These shall cross gas lines below the gas piping without exception.
11. Reconditioned or used devices e.g. switches, circuit breakers.
12. Radioactive and self illuminated exit signs.

B. Guarding:

1. Provide protection for moving parts and hazardous conditions.
2. Provide industrial accident and warning signs per ANSI and OSHA standards.
3. Erect and maintain suitable barriers, protective devices, temporary lights and warning signs for the protection of the public and employees.
4. Conform with applicable safety regulations, including those of the Owner's.

C. Temporary Electrical Service:

1. All temporary connections shall be approved by the Owner. Submit drawings to Owner's Representative for approval.
2. The Contractor shall provide labor and materials required for the installation and maintenance of temporary lighting and required power sources for the Contractor's equipment inside the building or construction site and for pedestrian walkways during the period of construction.
3. The building or construction site shall be sufficiently illuminated so that construction work can be safely performed. Special attention shall be given to adequately lighting stairs, ladders, pedestrian walkways, floor openings, etc. Walkway lights shall be controlled by a switch within the building or construction site.

D. Seismic Anchoring:

1. All switchgear and other free standing electrical equipment shall be anchored to withstand seismic forces for seismic zone IV, and meets requirements of California CCR, Title 24. Submit documentation of manufacturer's done on similar equipment which demonstrates compliance.
 2. Cable tray shall be installed complete with all seismic anchoring and bracing.
 3. Conduit supports shall be adequately sized and braced to comply with seismic criteria.
- E. Cleaning: Vacuum clean the interiors of all switchboards, substations, panelboards, transformers, motor control centers and transfer switches upon completion of all work to remove dust and debris. After cleaning, cover all equipment to prevent any construction dust from recurring. Before equipment is energized, vacuum all interiors a second time to assure clean equipment.
- F. Painting:
1. Touch up damaged or scratched paint on electrical equipment to match the manufacturer's original finish.

1.2 STANDARDS

- A. Standards: Comply with latest editions of applicable regulations and standards of:
1. Insulated Cable Engineers Association (ICEA).
 2. Institute of Electrical and Electronics Engineers (IEEE).
 3. National Electrical Manufacturers Association (NEMA).
 4. American National Standards Institute (ANSI).
 5. National Bureau of Standards (NBS).
 6. Certified Ballast Manufacturers (CBM).
 7. American Society for Testing and Materials (ASTM).
 8. Underwriter's Laboratories (UL).
 9. California Code of Regulations (Titles 8, 19, 22, 24).
 10. California Public Utilities Commission General Orders 95 and 128.
 11. National Electrical Code (NEC).[RBA note – redundant, included in Cal title 24]
 12. National Electrical Safety Code (NECS).
 13. InterNational Electrical Testing Agency (NETA).[RBA note – name changed but acronym is the same and capital "N" is retained]
 14. City of Long Beach, California Municipal Code
- B. Proof of such compliance shall be submitted to the Owner's Representative for approval.

1.3 QUALITY ASSURANCE

- A. All materials and equipment shall be of new and recent manufacture and supplied by manufacturer's authorized distributors. Reconditioned equipment shall not be permitted.
- B. All materials and equipment shall bear the inspection label of the underwriter's laboratories (UL) where applicable. Materials and equipment shall be the latest standard product and shall be of the grade indicated by the trade names given.
- C. If a material and equipment with UL listing is not available from any manufacturer, Contractor shall furnish materials and equipment tested and listed by a reputable independent testing organization acceptable to the Owner and the City of Long Beach.

1.4 SUBMITTALS

- A. General: Submittals shall be furnished by Contractor for each device, equipment, building wiring, medium voltage cable, light fixture controls, splicing and testing intended to be used on the project and as indicated in other sections. Submit material list and obtain review, prior to submission of manufacturer's data and shop drawings.
- B. Submittals: Piecemeal submittals will not be acceptable. Submit in brochure form with all listings referenced to applicable sections and paragraphs in the specifications. Listing items 'as specified' without both name of manufacturer and model number or type (designation) is not acceptable.
- C. Submit four (4) copies of each submittal to Engineer, unless otherwise specified or if the Contractor requires more than two (2) copies returned. Engineer will retain one (1) copy and one (1) copy will be forwarded to the Owner's representative. A single electronic submittal in PDF format bookmarked by section and equipment type will be accepted as an alternative to paper submittals.
- D. Material List: Contractor shall submit a complete list of approved materials and equipment proposed for the project including that which is exactly as specified. List to contain only manufacturer's name and reference to applicable sections and paragraphs of the specifications. List shall be submitted minimum 2 weeks prior to submission of required submittals.
- E. Any material or equipment installed without written approval shall be subject to immediate removal.
- F. Equipment Layout Drawings: 1/4" = 1'-0" scale "equipment layout drawings" shall be provided for equipment furnished under Division 16. Drawings shall show projected outline of each item of equipment proposed to be used including all working clearances and clearances for removal of equipment. Indicate any conflicts with other work. Submit drawings along with shop drawings for electrical equipment. Available spaces for equipment layout as shown on drawings are restricted. Contractor shall make sure that the equipment furnished, shall fit in the available space.
- G. Furnish a certificate from switchgear manufacturer confirming that the main components and devices proposed to be used on the project shall be available for replacement for a minimum period of five (5) years from the date of final acceptance of the project by the Owner.
- H. Furnish a list of materials within 30 days on notice to proceed indicating name of manufacturer and name of major equipment.

1.5 DELIVERY AND STORAGE

- A. All material and equipment including conduit shall be stored to provide protection from weather and accidental damage. Follow manufacturer's written instructions when available.
- B. Plastic conduit shall be stored on even supports and in locations not subject to direct sunrays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. High voltage cables shall be stored in accordance with manufacturer's recommendations.

1.6 ELECTRICAL PHASING AND PHASE SEQUENCE

- A. The Contractor shall maintain the present phasing and phase sequence at the facility. All new feeders being installed shall be checked and tagged for the proper phasing and phase sequence before connections to existing feeders and facilities.
- B. After phasing and sequence checks, existing and new cables shall be tagged with the proper phase nomenclature.
- C. The Contractor shall certify that circuits have been properly phased prior to paralleling.

1.7 ELECTRICAL SERVICE OUTAGES

- A. To allow the Owner to coordinate the manpower for transferring of loads, the Contractor shall provide, through the Owner's Representative, a list of all outages required during the construction period.
 - 1. The listing shall include, but not be limited to, the following:
 - a. Facility to be de-energized.
 - b. Time and duration of outage.
 - c. Date requested.
 - d. Alternate dates.
 - 2. Because of class schedules and other critical operations at the Owner, the timing of outages will be entirely at the direction of the Owner's Representative.

1.8 SEQUENCING OF ELECTRICAL WORK

- A. Outages for interruption of electrical services, see paragraph 1.06.
- B. Switching: All electrical loads shall be switched by Physical Plant Services (Owner) personnel upon receipt of notice.
- C. Coordination: The Contractor shall coordinate connections, circuit transfers, switching of loads, etc. with the Owner's Representative.
- D. Prior to energizing of new and existing electrical equipment, the following "check-list" procedures shall be followed:
 - 1. Correct phasing, phase sequence has been verified of all intended equipment, cable connections, and loads to be transferred. Tag existing and new conductors with phase identification markers.
 - 2. Thoroughly clean equipment enclosure interior. (Wipe down insulators, bus work, bushings, etc.) Remove any debris and check that all shipping blocks and strapping have been removed.
 - 3. Check that the key systems are operable. (The Owner's Representative shall supply keys for existing equipment.)
 - 4. Check operation of all switches.
 - 5. Assure that all parts (panels, fuses, jumpers, barriers, etc.) are in place.
 - 6. Check that the equipment ground bus is bonded to the grounding electrode system.
 - 7. Electrical equipment shall be securely anchored in place.
- E. Prior to starting work on the project, the contractor shall determine phase sequence at each location of work including connection point of temporary generators. Each individual cable shall

be tagged, i.e., A Phase, B Phase, C Phase. The sequence of new or temporary work shall be identical to existing conditions.

1.9 POSTED OPERATING INSTRUCTIONS

- A. Operating instructions shall be provided by the Contractor at the conclusion of the project for each system and each principal piece of equipment for the use of operating and maintenance personnel. The operating instructions shall include wiring and control diagrams showing the entire system, including, but not limited to, equipment, devices, and control sequences. All operating instructions shall be approved by the Owner's Representative.
- B. Operating instructions shall be typewritten or engraved and shall be framed under glass or in approved laminated plastic and posted adjacent to each principal piece of equipment and shall include such instructions as start up, proper adjustment, operation, lubrication, shutdown, safety-precautions, procedure in the event of equipment failure, and any other necessary items of instructions as recommended by the manufacturer of unit.
- C. Operating instructions exposed to the weather shall be made of weather-resisting materials or shall be suitably enclosed to be weather protected. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.10 TRAINING

- A. Owner staff and maintenance personnel shall be thoroughly trained (minimum four [4] hours) in the use of each system or major piece of equipment installed unless otherwise stated in other sections of Division 16. This training shall be provided as part of the Contractor's base bid to supply the system or equipment.

1.11 EQUIPMENT ANCHORING

- A. All equipment bases shall be fabricated with an adequate number of anchor bolt holes designed to put the base in direct contact shear and tension with the concrete pad at all anchor bolt locations. Anchorage shall be designed to utilize simple ASTM A307 anchor bolts with heads imbedded 4 inches in concrete with an ultimate compressive strength of 3000 psi.
- B. The mounting and attachment of the equipment to floor, pad or wall shall be designed for Seismic Zone 4 conditions. The contractor shall provide plans, anchor details and calculations, signed and stamped by a California registered structural engineer. This documentation shall be specific for the installation and submitted for review with the equipment shop drawings.

PART 2- PRODUCTS

Not Used

PART 3- EXECUTION

Not Used

END OF SECTION

SECTION 260030 ELECTRICAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Terms and Conditions, Service Providers Manual, Exhibit E of the Construction Contract and Section 01000, apply to this Section.

1.2 DESCRIPTION

- A. Acceptance field testing and power system study requirements for electrical power systems.

1.3 QUALITY ASSURANCE

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

- A. American National Standards Institute, Inc. (ANSI) Publication:
 - 1. C2-2007 National Electrical Safety Code
 - 2. C37.010-1999 Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 - 3. C37.16-2009 Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers
- B. InterNational Electrical Testing Association Inc. (NETA) Publication:
 - 1. ATS-1999 or latest edition of Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
- C. Institute of Electrical and Electronic Engineers (IEEE) Publications:
 - 1. 141-93 Recommended Practice for Electric Power Distribution for Industrial Plants
 - 2. 242-86 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - 3. 399-90 Recommended Practice for Industrial and Commercial Power System Analysis
 - 4. 446-95 Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications
- D. National Fire Protection Association (NFPA) Publication:
 - 1. 70-99 National Electrical Code (NEC)
- E. State of California Code of Regulations:
 - 1. Title 24, Part 3, CCR, 2007 California Electrical Code with latest amendments.

1.4 SUBMITTALS

- A. Submit six (6) copies under provisions of Sections 01340.
- B. Qualifications: Provide for:

1. Independent testing organization.
 2. Designated project safety representative.
 3. NETA Certified Lead Engineer to be assigned to the project.
 4. Power systems analysis firm.
- C. Acceptance Test Procedures: Provide for:
1. Ground fault protective systems
 2. Low voltage circuit breakers (>400A)
 3. Grounding system
 4. Meggar testing of 600V feeder conductors
- D. Short Circuit and Protective Device Coordination Study: Provide (6) copies in hard cover 3-ring binders, each including complete short circuit and protective device coordination studies. The study shall be submitted along with switchgear submittal. The Owner will not accept the switchgear submittal without the study.
- E. Certified Test Reports: The final report for each test shall be signed and shall include the following information: Summary of the project, name of technicians performing the test, date and time of testing, weather conditions, name of Owner's Representative witnessing the test, description of the equipment or cables tested, visual inspection report, description of the tests, test results, conclusions and recommendations, appendix including appropriate test forms, and identification of the test equipment used. Provide bound copies and submit within three (3) weeks of test completion for:
1. Ground fault protective systems
 2. Low voltage circuit breakers (>400A)
 3. Grounding system
 4. Meggar testing of 600V feeder conductors

1.5 POWER SYSTEMS STUDY AND DEVICE PROGRAMMING

- A. Provide short circuit and protective device coordination studies carried out by a professional electrical engineer registered in the State of California. Provide studies prepared by persons experienced in the work. Submit qualifications of individual(s) who will perform the work for approval prior to commencement of the studies. Provide studies in conjunction with equipment submittals to verify equipment ratings required. Submit a draft of the study to Owner's Representative for the review prior to delivery of the study to the Owner. Make all additions or changes as required by the reviewer at no extra cost to the Owner.
- B. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Study shall start at the Utility source of Owner 15KV power and extend to the equipment furnished under this project including multifunction relays. All multifunction relays shall have settings developed and be programmed to meet the configuration of the electrical distribution system.
- C. Short circuit and protective device studies must be prepared with a digital computer. Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, or generators as noted on Drawing one-lines.

- D. Utilize equipment load data for the study obtained by the Contractor from Contract Documents, including Contract Addendums issued prior to bid opening. Coordination study shall indicate proper coordination of protective devices furnished under the project with the upstream relays at the existing 15KV system. Verify existing setting of relays in field prior to start of work.
- E. Submit an electronic file on CD ROM of the approved study for the Owner's record.
- F. Recommended Power Study Firm: Electrical Reliability Services, Inc., Brea, CA (formerly ETI, Inc.).

1.6 QUALIFICATIONS

- A. The contractor shall engage the services of an independent testing organization fully certified by NETA and a full member to provide final inspection, testing, calibration, and adjusting on the electrical distribution system as defined in this Section. The independent testing organization shall have been engaged in full practice for a minimum of five years. The organization shall be independent of the supplier, producer, or installer of the equipment, and located within forty (40) miles radius of the project location. The organization shall be able to provide service and test equipment within four (4) hours.
 - 1. The independent testing organization shall have a calibration program with accuracy traceable every six months, and in an unbroken chain, to the National Institute of Standards and Technology (N.I.S.T.).
 - 2. The independent testing organization shall have a designated safety representative on the project. The safety standards shall include OSHA and NFPA 70E.
 - 3. Testing, inspection and calibration shall be performed by an Engineering Technician, certified by NETA, with a minimum 5 years experience inspecting, testing and calibrating electrical distribution equipment, systems and devices. Information on the qualifications of the Certified Engineering Technician shall be submitted to the Owner's Representative for approval minimum 45 days prior to the start of testing.
 - 4. The qualifications of the independent testing organization shall be submitted to the Owner's Representative for approval within 30 days of notice to proceed.
- B. The power system study and device programming shall be performed by an independent, third party firm not involved in supply of the equipment.
 - 1. The firm should be currently involved in high and low voltage power system evaluation. the study shall be performed, stamped and signed by a registered professional engineer in the State of California. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Owner's Representative for approval prior to start of the work. A minimum of 10 years experience in power system analysis is required for the individual in charge of the project.
 - 2. The firm performing the study must be able to document capability and experience to provide assistance during start up. The individual in charge of the study work should have a proven field experience. The individual in charge should be aware of most recent ANSI/IEEE changes and familiar with standards C37.010, C37.16, IEEE-141, IEEE-242, IEEE-399 and IEEE-446.
 - 3. Study shall be performed using SKM Systems 'Dapper' Version 3.5 and 'Captor' Version 3.5 programs to match existing studies. In addition to the software generated printouts, produce a short circuit device evaluation table including the bus number, bus name, phase and ground fault currents, X/R ratio, 110% of the calculated fault current, bus bracing, and A/C rating of the devices on the bus.
 - 4. Revise the study to include review comments at no additional cost to the Owner.

PART 2 - PRODUCTS - Not Used.

PART 3 - EXECUTION

3.1 All inspections shall be performed in accordance with applicable codes and standards including NEC, ANSI, IEEE, NEMA and OSHA.

- A. The independent testing organization shall provide all materials, equipment, labor and technical supervision to perform the inspections and tests.

3.2 IMPLEMENTATION OF POWER STUDY RESULTS AND DEVICE PROGRAMMING

- A. The drawings and specifications indicate the general requirements for the electrical equipment being provided. Changes and additions to equipment characteristics and ratings may be suggested by the results of the short circuit and protective device coordination studies. Submit any such proposed changes and additions as a part of the study material. Necessary field settings of devices, and adjustments and minor modifications to equipment to accomplish conformance with the accepted short circuit and protective device coordination studies shall be carried out by the particular manufacturer or by the Contractor at no additional cost to the Owner.

3.3 EVALUATION / TEST PROCEDURES:

- A. The contractor shall supply to the independent testing organization complete sets of approved shop drawings, coordination study, settings of all adjustable devices, and other information necessary for an accurate inspection and evaluation of the system prior to the performance of any tests.
- B. After the evaluation of the system and equipment has been made, the independent testing organization shall submit for approval an acceptance test procedure for each item of electrical distribution equipment to be tested. Test procedures shall include the proposed system function test. No testing shall be performed until the test procedures have been reviewed and approved.

3.4 INSPECTION

- A. A visual inspection of the installed equipment shall be performed by the independent testing organization to verify that the distribution equipment installed and to be tested is the equipment denoted on the approved shop drawings. The inspection shall check the equipment designations, device characteristics, special installation requirements, applicable codes and standards.
- B. After completion of the visual inspection, a report shall be developed stating any discrepancies that may have been found.

3.5 TESTING, CALIBRATION AND ADJUSTMENT

- A. The independent testing organization shall perform tests on each item of distribution equipment identified in accordance with the latest edition of the International Electrical Testing Association's (NETA) Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.
- B. Submit description of tests based on NETA specifications for approval prior to testing.
- C. Field acceptance testing shall be accomplished on each item of electrical distribution equipment installed or connected as part of this contract. This shall include:
 - 1. Ground fault protective systems
 - 2. Low voltage circuit breakers (>400A)
 - 3. Grounding system

4. Description of tests for each equipment, cable, conductor
 5. Meggar testing of 600V feeder conductors
- D. Systems shall be energized or otherwise placed in service only after completion of all required tests and an evaluation of the test results has been completed.

3.6 SYSTEM FUNCTION TESTS

- A. Each system provided under this Contract and covered by this Section shall be function tested to ensure total system operation. All tests shall be witnessed by Owner's Representative. Provide minimum (14) days written notice to the Owner's Representative prior to scheduling each test.
- B. Upon satisfactory completion of equipment acceptance tests, the system functional tests shall be performed. It is the intent of system functional tests to prove the proper interaction of all sensing, processing, and action devices to effect the designed end product or result.
- C. All interlocks, safety devices, fail-safe functions, and design functions shall be tested.

3.7 CORRECTION OF DEFICIENCIES: Any deficiencies found shall be rectified, and work affected by such deficiencies shall be completely re-tested at the Contractor's expense. Final acceptance of the electrical power system is contingent upon satisfactory completion of the acceptance and system function tests.

END OF SECTION

**SECTION 260050
BASIC MATERIALS AND METHODS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Terms and Conditions, Service Providers Manual, Exhibit E of the Construction Contract and Section 01000, apply to this Section.
- B. Section 16030 - Electrical Acceptance Testing
- C. Section 16170 - Grounding and Bonding
- D. Section 16195 - Electrical Identification

1.2 DESCRIPTION

- A. Conduit
- B. Fittings and Conduit Bodies
- C. 600 Volt Wires
- D. Boxes
- E. Panelboards
- F. Safety Switches
- G. Cabinets and Enclosures

1.3 QUALITY ASSURANCE

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

- A. American National Standards Institute, Inc. (ANSI) Publications:
 - 1. C80.1-95 Rigid Steel Conduit, Zinc Coated
 - 2. C80.3-95 Electrical Metallic Tubing, Zinc Coated
 - 3. C80.5-90 Specification for Rigid Aluminum Conduit
 - 4. FB 1-97 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
 - 5. OS 1-84 Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
 - 6. OS 2-84 Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
- B. National Electrical Manufacturers Association (NEMA) Publications:
 - 1. AB 1-93 Molded Case Circuit Breakers
 - 2. ICS 2-93 Industrial Control Devices, Controllers, and Assemblies
 - 3. ICS6-93 Enclosures for Industrial Controls and Systems
 - 4. KS 1-96 Enclosed Switches
 - 5. PB 1 Panelboards

6. PB 1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
7. TC 2-90 Electrical Plastic Tubing and Conduit
8. WD 1-83 General Purpose Wiring Devices
9. WD 6-88 Wiring Device Configurations

C. National Fire Protection Association (NFPA) Publication:

1. 70-2005 National Electrical Code (NEC)

D. State of California Code of Regulations:

1. Title 24, Part 3, CCR, 2007 California Electrical Code

E. Underwriters Laboratories, Inc. (U.L.) Publications:

1. 1-93 Standard for Flexible Metal Conduit
2. 6-93 Rigid Metallic Conduit
3. 50-95 Cabinet and Boxes
4. 67-79 (R86) Panelboards
5. 83-91 Thermoplastic Insulated Wires
6. 198E-88 Class R Fuses
7. 360-96 Liquid-tight Flexible Steel Conduit
8. 486A-91 Wire Connectors and Soldering Lugs, for use with Copper Conductors
9. 498-96 Attachment Plugs and Receptacles
10. 508-93 Industrial Control Equipment
11. 510-94 Insulating Tape
12. 514A- 91Metallic Outlet Boxes
13. 514B-89 Fittings for Conduit and Outlet Box
14. 651-95 Schedule for 40 & 80 Rigid PVC Conduit
15. 797-93 Electrical Metallic Tubing
16. 869A-93 Standard for Service Equipment
17. 1242-96 Standard for Intermediate Metal Conduit

F. National Electrical Contractors Association (NECA)

1. National Electrical Installations Standards [RBA note; Cited in several locations]

1.4 SUBMITTALS

A. Submit under provisions of Sections 16010.

B. Product Data: Provide for:

1. Conduit and Connectors (all types)
2. Conductors (all types)
3. Cabinets, Enclosures and Junction Boxes
4. Safety Switches
5. Panelboards: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.
6. Surface Mount Raceways

C. Test Reports: Provide for:

1. Insulation resistance tests of low voltage conductors.
2. Operational tests.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 16010.
- B. Accurately record actual routing of all conduits.
- C. Accurately record actual locations and mounting heights of outlet, pull and junction boxes.
- D. Accurately record actual location of each new receptacle.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70 and with all state adopted amendments, except where requirements herein are more stringent.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.8 PROJECT CONDITIONS

- A. The drawings are diagrammatic and shall not be scaled for exact locations: Field conditions and non-interference with other utilities and trades, shall determine exact locations.
- B. Verify routing and termination locations of conduit prior to rough-in.
- C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

1.9 PROJECT/SITE CONDITIONS

- A. The arrangement of and connection to equipment shown on the drawings is based upon information available to the Engineer at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer. The drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment requirements.
- B. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.

1.10 COOPERATION WITH WORK UNDER OTHER DIVISIONS

- A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.
- B. Make such progress in the Work to not delay work of other trades.

1.11 DISCREPANCIES

- A. The Contractor shall check all drawings furnished to him immediately upon their receipt and shall promptly notify the Engineer of any discrepancies. Figures marked on Drawings shall in

general be followed in preference to scale measurements. Large-scale drawings shall in general govern small-scale drawings. The Contractor shall compare all drawings and verify the figures before laying out the work and will be responsible for any errors, which might have been avoided thereby.

- 1.12 CHANGES: The Contractor shall be responsible to make and obtain approval from the Engineer for all necessary adjustments in piping layouts as required to accommodate the relocation of equipment and/or devices which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.**

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated. Except where specifically indicated otherwise, provide only new materials having all legally required approvals and/or labels. Items of a similar nature shall be of the same type and manufacturer.

2.2 CONDUIT

- A. Rigid Steel Conduit (Zinc-coated): ANSI C80.1, UL 6, hot-dip galvanized, threaded type.
- B. Electrical Metallic Tubing: UL 797, ANSI C80.3.
- C. Rigid Plastic Conduit: NEMA TC-2, UL 651, PVC Schedule 40 and 80, Carlon or equal.
- D. Liquidtight Flexible Non-Metallic Conduit: UL 1660, Non-metallic, liquid-tight conduit with a polyvinyl chloride reinforced core. Conduit must conform to NEC 351B. Electri-Flex Liqueatite® Type LNM-P, Kellems Polytuff I or equal.
- E. Flexible Metal Conduit: UL 1.
- F. All conduits, fittings and supports in the cooling tower area shall be PVC coated galvanized steel. All junction or pull boxes shall be NEMA 4X stainless steel. All other supports and hardware shall be stainless steel.

2.3 FITTINGS

- A. Fittings for Rigid Metallic Conduit: UL 514B, threaded-type.
- B. Fittings for EMT: Compression type. Split or set-screw couplings unacceptable.
- C. Fittings for Liquidtight Flexible Non-Metallic Conduit: ANSI/NEMA FB 1.
- D. Fittings for Flexible Metal Conduit: ANSI/NEMA FB 1.
- E. Expansion/Deflection Fittings: Provide fitting capable of a straight line expansion movement of 2" in either direction and a movement of 3/4" from the normal in all other directions, OZ Gedney Type AXDX, or Equal (no known Equal). Provide complete with grounding and bonding jumpers.

2.4 CONDUCTORS: Conductors shall bear the date of manufacture imprinted on the insulation with other identification. Wire and cable manufactured more than 6 months before delivery to the job site shall not be used.

- A. 600 Volt Wires and Cables: UL 83. Conductors shall be stranded copper unless otherwise noted. Insulation shall be type THHN/THWN unless otherwise noted. Conductors shall be stranded from exterior lighting underground handholes to the pole mounted fixture.
- B. Color Coding: Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutral shall be white with colored (not green) stripe. Color of ungrounded conductors in different voltage systems shall be as follows:
 - 1. 208Y/120 volt, 3Ø:
 - a. Phase A - black
 - b. Phase B - red
 - c. Phase C - blue.
 - 2. 480Y/277 volt, 3Ø:
 - a. Phase A - brown
 - b. Phase B - orange
 - c. Phase C - yellow.
- C. Minimum size for branch circuits shall be No. 12 AWG, unless otherwise noted.

2.5 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported, include 1/2 inch male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type.
- B. Outlet Boxes: ANSI/NEMA OS 2.
- C. Cast Boxes: NEMA FB 1, Type FD, cast fer alloy. Provide gasketed cover and threaded hubs by box manufacturer.

2.6 CABINETS: UL 50.

- A. Cabinets for same type of use shall be the product of a single manufacturer.
- B. Construct of cold-rolled drawing quality steel, with metal gages and construction methods conforming to National Electrical Code requirements, and Underwriters Laboratories' standards. Provide 12 gauge G-90 grade galvanized steel minimum, unless otherwise noted.
- C. Finish doors, trims, and back boxes for surface-mounted cabinets in finished areas by applying a rust-resistant treatment, prime coat, and a final coat of manufacturers standard enamel or lacquer finish. Galvanize all other sheet metal components of cabinets including back boxes for flush cabinets, excepting non-ferrous metal parts, or steel parts provided with cadmium plating or equivalent protective plating.
- D. Equip doors with concealed or semi-concealed hinges and with flush or semi-flush spring catch type flush cylinder locks. Key cabinet doors of similar use alike, and provide two keys with each lock.

- E. Equip cabinets for use with telephone, alarm or signal systems with a 0.5" thick plywood backboard. Equip cabinets with terminal strips where so specified. Equip cabinets with nameplates.
- F. Surface cabinets shall be furnished without knockouts. Punch or drill required openings during installation. Equip flush back boxes with manufacturer's standard pattern of knockouts.
- G. Equip cabinet doors exceeding 40" in height with vertical bolt three point locking mechanisms.
- H. Acceptable manufacturers: Products of the following manufacturers are acceptable.
 1. Cabinets for general use: Hoffman Engineering Co., Square D, Columbia Manufacturing Co, or Equal.
 2. Cabinets for systems and/or products, use cabinets furnished by manufacturer with system or product. Where system or product cabinets do not comply with these Specifications, submit cabinet shop drawings, indicating deviations, and obtain approval for their use.

2.7 JUNCTION BOXES AND PULL BOXES: UL 50.

- A. Provide pull and junction boxes of Code gauge steel sized as indicated or required. Provide 16 gauge steel minimum, unless otherwise noted. Indoor enclosures shall conform to NEMA ICS 6 for the type 1, unless otherwise noted.
- B. Size junction and pull boxes to not less than minimum Code requirements. Increase size above Code requirements where necessary to provide space for pulling, racking or splicing enclosed conductors, or where specified or indicated dimensions exceed Code requirements.
- C. Fabricate sheet metal junction and pull boxes of galvanized, Code gage, sheet steel. Include angle iron framing where required for rigidity. Boxes shall not deflect or deform visibly when covers are removed after conduit and conductors are installed, and any deflection occurring shall not prevent the easy installation and removal of cover attachment screws.
- D. Do not use single covers for junction and pull boxes having cover length or width dimension exceeding three feet unless so specified, indicated, or approved. Sectionalize covers that exceed three feet in either dimension into two or more sections.
- E. Equip metal junction and pull boxes exposed to weather (and not installed in or below grade) with raintight or weatherproof removable covers. Enclosures shall conform to NEMA ICS 6 for the type 3R, unless otherwise noted. Rain tight or weatherproof boxes shall be used threaded watertight hubs for top or side entry and may use knockout for bottom entry only. For exterior pull boxes, use a minimum of 14 gage galvanized G-90 grade sheet steel.
- F. For interior junction and pull boxes located in concrete floors, and 24" square or smaller, use cast iron boxes with integral cast tapped conduit hubs, and having recessed cover flush in the box trim placing all elements of the face of the box flush in the plane of the surrounding floor. Equip boxes with watertight covers where so indicated.
- G. For interior pull boxes located in concrete floors and larger than 24" square, use precast concrete boxes or form these boxes at the job site. Equip with angle iron cover rim, and with reinforced steel cover plate set flush with the finish floor plans. Specific plan details shall supersede these general requirements.
- H. Equip surface sheet metal junction and pull boxes with covers aligning with the sides of the boxes and equip flush boxes with covers extending 3/4" all around the perimeter of the back box. Provide sufficient cover attachment screws to ensure that box covers will contact the

surface of the box for the entire perimeter of the enclosure. Use galvanized or cadmium-plated screws, or brass screws to attach covers to boxes.

- I. Use brass screws to attach junction and pull box covers to interior floor boxes or to boxes located where moisture may be present.
- J. Acceptable manufacturers:
 - 1. Sheet steel junction and pull boxes: Hoffman Engineering Co., Columbia Manufacturing Co., Pico Metal Products Co, or Equal.
 - 2. Cast iron junction and pull boxes: O.Z. Electric Manufacturing Co., Alhambra Foundry Co., Ltd., Crouse Hinds Co, or Equal.
 - 3. Concrete junction and pull boxes: Brooks Products Inc., Quickset Co, or Equal.

2.8 PANELBOARDS

- A. Panelboards: UL 50, UL 67, NEMA PB1, circuit breaker type, size and number of breakers as indicated.
- B. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard. Where isolated ground bus is required, a ground bus shall be mounted on insulators isolated from the enclosure.
- C. Minimum short circuit rating: 10,000 amperes rms symmetrical for 240 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated. Series ratings are not acceptable. Panel boards shall be fully rated for the available fault.
- D. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type, ambient compensated, thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers. Where main breaker is shown as non-automatic, it shall be equipped with high magnetic trip with same interrupting capacity as all branch circuit breakers.
- E. Enclosure: NEMA PB 1, Type 1 or as indicated.
- F. Cabinet box: 6 inches deep; width: 20 inches.
- G. Cabinet Front: Flush or surface cabinet front as indicated with concealed trim clamps, door – in – door type, concealed hinge, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- H. Panelboard manufacturer shall be Square D Model NQOD or equal.

2.9 SAFETY SWITCHES

- A. NEMA KS 1. Switches serving as motor-disconnect shall be horsepower rated. Provide heavy-duty type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Fused switches shall utilize Class R fuseholders and fuses unless indicated otherwise. Unless otherwise indicated, provide indoor switches in NEMA Type 1 enclosure, per NEMA ICS 6. Provide outdoor switches in NEMA Type 3R enclosure, per NEMA ICS 6.
- B. Unless otherwise indicated or required, use only unfused type for motor or equipment disconnects. Provide switches for the number of poles and the voltage, current and horsepower ratings as required.

- C. Provide each switch with a nameplate indicating equipment controlled.
- 2.10 WIRE CONNECTORS AND TERMINALS: For use with copper conductors. UL 486A.**
- 2.11 INSULATING TAPES: UL 510.**
- 2.12 NAMEPLATES: Provide as specified in Section 16195, "Electrical Identification."**

PART 3 - EXECUTION

3.1 INSTALLATION: Electrical installation shall conform to requirements of NFPA 70, state codes, and to requirements specified herein.

3.2 LOCATIONS

- A. The drawings indicate diagrammatically the desired locations and arrangements of the components of the electrical work. Follow the drawings as closely as possible, but use judgement and coordinate with other trades to secure the best possible installation in the available space and under the developed conditions.
- B. Before installing any equipment, conduit, or locating any outlet, examine the complete set of documents, including shop drawings and specifications, and verify all dimensions and space requirements. Make such minor adjustments as may be necessary to fit the building structure and accommodate the work of other trades. Install all electrical work to preserve legal headroom, access, work space, clearances and to keep openings and passage ways clear. Arrange for additional space if required for the servicing, maintenance, and replacement of the electrical equipment.
- C. Control devices shall not be mounted more than 48" above the floor to the center of the device.
- D. Prior to installation, the Owner reserves the right to relocate any outlet or device within six feet of the location indicated on the plans and at no additional cost to the Owner.
- E. No additional compensation will be allowed for omissions, inadequate space, misunderstandings or rejected work caused by neglect of these requirements.

3.3 CONDUIT

- A. Rigid steel conduit shall be used for following applications:
 - 1. Installations exposed to weather including under canopy and soffit.
 - 2. Wet locations
 - 3. Rigid steel conduit shall not be installed below grade in direct contact with earth.
 - 4. Provide "DANGER - HIGH VOLTAGE" labels on exposed conduits containing circuits greater than 600 Volts. Refer to Section 16195.[RBA – is this a client requirement?]
 - 5. Mechanical and electrical equipment rooms.
 - 6. Where noted on drawings.
- B. Electrical metallic tubing (EMT) shall be installed in indoor dry locations only. Minimum size ¾" restrictions applicable to EMT:
 - 1. Do not use for feeder circuits.
 - 2. Do not install below grade.
 - 3. Do not encase in concrete.
 - 4. Do not use in areas subject to severe physical damage.
 - 5. Do not use in hazardous areas.

- C. Do not use outdoors.
- D. Use liquidtight flexible conduit (maximum 6 feet) for final connections to lighting fixtures in accessible ceilings, motors, transformers and other vibration type equipment, or with the approval of the Owner's Representative, where absolutely necessary due to structural conditions. Provide green ground conductor in all flexible conduit.
- E. Install conduit in accordance with NECA "Standard of Installation." The electrical drawings are diagrammatic and do not show all offsets, bends, fittings, junction boxes, pull boxes and expansion fittings required to meet field conditions. Determine actual material and hardware requirements and verify all dimensions by field inspection.
- F. Arrange supports to prevent misalignment during wiring installation.
- G. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- H. Group related conduits; support using conduit rack. Construct rack using steel channel provide space on each for 25 percent additional conduits.
- I. Arrange conduit to maintain headroom and present neat appearance.
- J. Route exposed conduit parallel and perpendicular to walls.
- K. Maintain adequate clearance between conduit and piping.
- L. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees.
- M. Cut conduit square using saw or pipecutter; de-burr cut ends.
- N. Bring conduit to shoulder of fittings; fasten securely.
- O. Provide pull fittings in all overhead conduit runs exceeding 200 feet of straight conduit, or having more than the equivalent of three 90 degree bends. Each 90 degree bend shall be considered the equivalent of 50 feet of straight run. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate or factory elbows for bends in metal conduit larger than 2 inch size.
- P. Where conduit passes from one type of construction to another, or where there is a possibility of dissimilar movements, an expansion/deflection device or a suitable loop of sealtight flexible conduit shall be installed. Looped sealtight flexible conduit shall consist of 18" minimum length of looped conduit with a junction box at one or both ends, wherever conduit crosses building seismic joints.
- Q. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- R. Conduit which penetrates fire walls, fire partitions, or floors shall be metallic on both sides of fire walls, fire partitions, or floors for minimum distance of 6 inches. Restore fire rating integrity at conduit penetration. All holes created to extend electrical systems through fire rated floors and walls shall be sealed by the contractor with an intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures beginning at 250°F. It shall be UL Classified and have I.C.B.O., B.O.C.A.I. and S.B.C.C.I. (NRB 243) approved ratings to three hours per ASTM E-814 (UL 1479).
 - 1. Manufacturers: 3M, Carborundum, Hevi-Duty/Nelson, or equal.

- S. Where conductors of No. 4 AWG or larger are to be installed in a conduit, or where any conductors are to be deflected more than 30 degrees when leaving a conduit, terminate the conduit with an insulating bushing.
- T. Ground and bond conduit under provisions of Section 16170.
- U. Pull wires. Provide a 1/8" size polypropylene pull wire in all empty conduits up to 2", including those for signal and telephone system. Pull cord in conduits (2" and larger) shall be 3/16" size. Identify conduits at exposed ends with tags. Tags shall identify location of other end of conduit. The pull wire shall be left with more than 5 feet in length at both ends for future use.

3.4 600 VOLT CONDUCTORS

- A. Splices:
 - 1. Splices in conductors #8 AWG and smaller shall be made with "Scotchlok" insulated connectors or equal (no known Equal) of proper size for conductors being spliced.
 - 2. Splices in conductors #6 AWG and larger shall be made with pressure type solderless connectors. The splice area shall be taped to provide equal or greater insulation than the original. Tape run-back over the original insulation shall extend 3 to 5 overall diameters of the insulated wire.
- B. Connectors and terminal lugs shall be used for terminating stranded conductors #6 AWG and larger and shall be T&B, IlSCO, or Equal solderless connectors.
- C. Wire in panels, cabinets, pull boxes and wiring gutters shall be neatly grouped, strapped together with T&B Model Tyrap cable strap, or equal (no known equal), or laced with #12 stranded lacing twine and fanned out to the terminals.
- D. Neutral conductor shall be continuous in outlet boxes and shall not be broken by addition or removal of devices.
- E. Wiring methods in return air plenum spaces shall comply with NEC 300-22.
- F. Splices in underground pull boxes and hand holes shall be made using epoxy kit made by '3M' or equal (no known equal).

3.5 FITTINGS

- A. Use threaded fittings for rigid metal conduit and compression fittings for electrical metal tubing (EMT).
- B. Use cement-on fittings for plastic conduit.
- C. Fittings for flexible conduit shall be of the threadless hinged clamp type. Do not use fittings threaded internally into the flexible conduit ends.
- D. Use fittings made of the same material as the raceway except:
 - 1. Malleable iron and steel are interchangeable.
 - 2. Die cast fittings may be used for flexible steel conduit and for factory manufactured offsets.
 - 3. Use aluminum fittings only with aluminum conduit.
 - 4. Use plastic insulated bushings for conduit sizes larger than 1".
 - 5. Use insulated throat connectors for electrical metallic tubing.

3.6 CABINETS

- A. Set cabinets at heights indicated or specified. In the absence of such information, set cabinets at not to exceed 6'-6" from finish floor to top of cabinet.
- B. Align tops of cabinets in sight of each other at a uniform height.
- C. Install cabinets and other enclosure products in plumb with the building construction. Install flush enclosures so that the trim will rest against the surrounding surface material around the entire perimeter of the enclosure.
- D. Where cabinets are located in poured-in-place concrete wall construction, brace internally with temporary wood or other bracing to prevent deformation of the back or sides of the enclosure.
- E. Do not locate cabinets (or other electrical enclosures) where room doors will touch enclosure face when room door is opened 180°. Locate cabinets (and other enclosures) so that enclosure door can be opened through a minimum 180° arc, except that the arc may be reduced to 130° for enclosures mounted to wireways. Do not install surface mounted cabinets in finished areas, unless so indicated. Where conflicting data is indicated, verify mounting requirements prior to ordering cabinets.

3.7 WIRING DEVICES

- A. Use products of a single manufacturer for each type of wiring device. Different manufacturers may be used for different type devices, if the requirements of the specification are fulfilled.
- B. Use the products of a single manufacturer for all device plates. Obtain prior approval for any variations from this requirement except that plate variations are allowed for the following devices:
 - 1. Where the selected plate manufacturer does not manufacture a suitable finish plate.
 - 2. For heavy-duty receptacles rated at more than 30 amperes.
 - 3. Where the raceway system enclosure employs a non-standard finish plate.
 - 4. Where non-standard plates are specified or indicated.
- C. Position receptacles so that the ground contact in grounding type receptacles is on top of parallel prongs.
- D. Install adjacent devices of the same type and with the same mounting height in a common outlet box.
- E. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with specialty building equipment requiring very exact electrical rough-in.

3.8 BOXES, OUTLETS AND SUPPORTS: Provide boxes in wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when installed exposed up to 7 feet above interior floors, when installed under raised floor or when installed in hazardous areas. Boxes in other areas shall be sheet steel. Each box shall have volume required by NFPA 70 for number of conductors enclosed in the box. Provide gaskets for cast-metal boxes installed in wet locations.

3.9 JUNCTION AND PULL BOXES

- A. Wherever possible use outlet boxes for junction and pull boxes.

- B. Locate interior junction and pull boxes in machine rooms, equipment rooms, storage rooms, electrical rooms and similar utility spaces unless otherwise indicated or approved. Where junction or pull boxes must be used in finished areas, use flush boxes only equipped with prime finished sheet metal plates. Fasten plates to boxes with countersunk flat head screws. Provide plates with 3/4" trim all around.
- C. Do not use sectionalized boxes except where indicated. Do not mix feeder and branch circuit conductors in a common pull or junction box.
- D. Where more than one circuit passes through a common junction or pull box, tag conductors to indicate circuit number and panel designation.

3.10 OPENINGS, CHASES AND SLEEVES

- A. Provide openings, chases, cutting, patching, sleeves and other products, necessary to permit the electrical raceways and cables to pass through the structure.
- B. Establish locations for openings, chases and sleeves sufficiently in advance of construction to avoid cutting and patching. Perform any required cutting and patching for electrical work and obtain approval for cutting from Owner's Representative prior to work being done.
- C. Repair damages to finished work and surfaces caused by cutting, to the satisfaction of Owner.
- D. Install sleeves wherever raceways of any type pass through walls or floors above grade, except that sleeves are not required for drywall construction or laid up masonry construction used for interior partitions and not fire rated.
- E. Use pipe or sheet steel sleeves for interior dry locations.
- F. Install sleeves with both ends flush with wall surfaces and with upper ends 3" above floor surfaces. Install bottom end of floor sleeves flush with slabs if not concealed by ceiling system. Use steel pipe sleeves through floors.
- G. Furnish galvanized steel 24 gauge roof jacks and pitch dams for roof penetrations. For installation of roof jacks and pitch dams (pockets), refer to Architectural drawings. Size roof jacks to extend 6" out on roof and 8" up conduit above roof. Solder or braze a flashing collar to conduits passing through roof jacks. Size pitch dams to extend 6" above roof and 6" beyond roof opening.
- H. Core drill existing concrete walls or slabs to pass new runs of conduit or tubing. Seal core drilled openings as described for sleeves.
- I. For exterior walls below grade conduit entries, use manufacturer fabricated wall entrance seals.

3.11 PANELBOARDS

- A. Install panelboards in accordance with NEMA PB 1.1 and NECA Standard of Installation.
- B. Align and level panelboards and securely fasten to the building. Do not use connecting conduits to support the panelboards. Install trim plumb and square.
- C. Height: 6 ft to top of panelboard; install panelboards taller than 6 ft with bottom no more than 4 inches above floor.
- D. Provide filler plates for unused spaces in panelboards.

- E. Provide typed circuit directory for each branch circuit panelboard affected by work under this contract. Revise directory to reflect circuiting changes required to balance phase loads.
- F. Provide engraved plastic nameplates under the provisions of Section 16195.

3.12 MOUNTING HEIGHTS: Mount disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor or platform. When installing switch next to existing switch, match mounting height of existing switch.

3.13 FIELD TESTS: Refer to Section 16030, "Acceptance Testing," for additional requirements. The Contractor shall provide all test equipment and personnel and submit written copies of all test results.

- A. Distribution Conductors, 600 Volt Class: Test all conductors #10 AWG and larger to verify that no short circuits or accidental grounds exist. Tests shall be made using an instrument which applies a voltage of approximately 500 volts and providing a direct reading of resistance in ohms. Insulation resistance, corrected to 60°F, shall not be less than the following values:

250-750 kcmil	50 megohms
4-4/0 AWG	50 megohms
10-6 AWG	100 megohms

Record resistance readings, temperature and weather conditions on the test form.

- B. Operational Tests: Demonstrate the operation of each switch, relay and other item of electrical control with the system fully energized and operating. Each shall be demonstrated three times. Any faulty or defective Contractor furnished materials and workmanship found during the tests shall be replaced or corrected by the Contractor at no additional cost to the Owner.

END OF SECTION

SECTION 260060 ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition required for site/building demolition and modifications to existing buildings.
- B. Contractor shall provide electrical demolition required for work noted on drawings MD2-2, MD2-3 and ED2-1.

1.2 RELATED SECTIONS

- A. Section 01560 - Environmental Protection.
- B. Section 02060 - Building Demolition.
- C. Section 02110 - Site Clearing.

1.3 APPLICABLE PUBLICATIONS: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

- A. Environmental Protection Agency (EPA) Regulations:
 - 1. 40 CFR 261 Regulations Identifying Hazardous Waste
 - 2. 40 CFR 262 Regulations for Hazardous Waste Generators
 - 3. 40 CFR 263 Regulations for Hazardous Waste Transporters
 - 4. 40 CFR 264 Regulations for Owners and Operators of Permitted Hazardous Waste Facilities
- B. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Regulation:
 - 1. 29 CFR 1910.94 Subpart G, Occupational Health and Environmental Control
- C. Department of Transportation (DOT):
 - 1. 49 CFR 178 Regulations for Shipping Container Specifications

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to Engineer before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Coordinate electrical outages with Trustees.
- C. Provide temporary wiring and connections to maintain existing systems in-service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work under provisions of this Section and as indicated on the drawings.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply unless otherwise indicated.
- D. Remove exposed abandoned conduit. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
- F. Disconnect and remove abandoned distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaires. Remove, relocate or provide brackets, hangers, and other accessories as required.
- I. Repair adjacent construction and finishes damaged during demolition and extension work.
- J. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- K. Extend existing installations using materials and methods as specified in Section 16050, "Basic Materials and Methods."

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.

END OF SECTION

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: **[Copper] [or] [tinned-copper]** wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.

- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad; 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
 - 10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 - 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 - 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
 - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [tinned bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 LABELING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. 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. Make tests at ground rods before any conductors are connected.
- B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 260533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
3. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.2 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

- B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. ARC: Comply with ANSI C80.5 and UL 6A.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- F. EMT: Comply with ANSI C80.3 and UL 797.
- G. FMC: Comply with UL 1; zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ENT: Comply with NEMA TC 13 and UL 1653.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

- D. LFNC: Comply with UL 1660.
- E. Continuous HDPE: Comply with UL 651B.
- F. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
- G. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- H. Fittings for LFNC: Comply with UL 514B.
- I. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- J. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, 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.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
- D. Tele-Power Poles:
 - 1. Material: Galvanized steel with ivory baked-enamel finish.
 - 2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
 - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
 - 1. Listing and labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep)
- M. Gangable boxes are prohibited.
- N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 and Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Fiberglass.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- O. Cabinets:
 - 1. NEMA 250, Type 1 and Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 - 1. Standard: Comply with SCTE 77.
 - 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, "ELECTRIC."
 - 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of fiberglass.
 - 1. Standard: Comply with SCTE 77.

2. Configuration: Designed for flush burial with **[open] [closed] [integral closed]** bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "**ELECTRIC**".
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit: RNC, Type EPC-40-PVC.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
 1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: RNC identified for such use.
 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: IMC.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use compression, steel 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.

- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

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 (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. 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 (300 mm) of changes in direction.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from ENT to GRC before rising above floor.
- I. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. 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.
- K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. 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 (35-mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- O. Surface Raceways:
1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
- Q. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- R. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m).
 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 (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) 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 degree F (0.06 mm per meter of length of straight run per degree C) of temperature change for PVC 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.
- S. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- T. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to **[center]** **[top]** **[bottom]** of box unless otherwise indicated.
- U. 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. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- V. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- W. Locate boxes so that cover or plate will not span different building finishes.
- X. 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.
- Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- Z. Set metal floor boxes level and flush with finished floor surface.
- AA. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
 2. Install backfill as specified in Section 312000 "Earth Moving."
 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 (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
 4. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.

- b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

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 (12.5-mm) sieve to No. 4 (4.75-mm) 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 (25 mm) above finished grade.
- D. 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 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 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 POWER RACEWAY 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 size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. White letters on an black.
 - 2. Legend: Indicate voltage and system type.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 ARMORED 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. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. **[Black letters on an orange field] <Insert color scheme>.**
 - 2. Legend: Indicate voltage **[and system or service type]**.
- 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.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.3 POWER AND CONTROL 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. 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.
- C. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. 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.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- D. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical [**and communications**] utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: **ELECTRIC LINE, HIGH VOLTAGE.**
 - 3. Inscriptions for Orange-Colored Tapes: **TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE** or **OPTICAL FIBER CABLE.**
- C. Tag: Type I:
 - 1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - 2. Thickness: 4 mils (0.1 mm).
 - 3. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).
 - 4. 3-Inch (75-mm) Tensile According to ASTM D 882: 30 lbf (133.4 N), and 2500 psi (17.2 MPa).
- D. Tag: Type ID
 - 1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

2.7 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. Baked-Enamel Warning Signs:
 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 3. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs:
 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 3. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. 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 (915 MM)."

2.8 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 1. Engraved legend with white letters on black face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. 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 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding 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 (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (400 mm) overall.
- G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Install labels at 10-foot (3-m) maximum intervals.

- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
1. Emergency Power.
 2. Power.
 3. UPS.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded, service, feeder and branch-circuit conductors.
 - a. Color shall be factory applied[or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) 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.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless

otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.

- J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

- K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer or load shedding.

- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Adhesive film label or Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved or melamine label 4 inches high.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION

SECTION 260923 LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. **[Indoor occupancy] [switchbox-mounted occupancy] [and] [outdoor motion] sensors.**
- B. Related Requirements:
 - 1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
- B. **Basis-of-Design Product:** Subject to compliance with requirements, provide **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - 1. Cooper Industries, Inc.
 - 2. Intermatic, Inc.
 - 3. Invensys Controls.
 - 4. Leviton Mfg. Company Inc.
 - 5. NSi Industries LLC; TORK Products.
 - 6. Tyco Electronics; ALR Brand.
 - 7. **<Insert manufacturer's name>.**
- C. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Contact Configuration: [SPST] [DPST] [DPDT] <Insert configuration>.
3. Contact Rating: [30-A inductive or resistive, 240-V ac] [20-A ballast load, 120-/240-V ac] <Insert rating>.
4. Programs: Eight on-off set points on a 24-hour schedule[and an annual holiday schedule that overrides the weekly operation on holidays].
5. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week[and an annual holiday schedule that overrides the weekly operation on holidays].
6. Programs: <Insert number> channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
7. Programs: <Insert number> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule with a skip-a-day weekly schedule.
8. Programs: <Insert number> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
9. Programs: <Insert number> channels; each channel is individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
10. Programs: <Insert number> channels; each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
11. Programs: <Insert configuration>[and an annual holiday schedule that overrides the weekly operation on holidays].
12. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program[on selected channels].
13. Astronomic Time: [All] [Selected] channels.
14. Automatic daylight savings time changeover.
15. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

D. Electromechanical-Dial Time Switches: Comply with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Contact Configuration: [SPST] [DPST] [SPDT] [DPDT] <Insert configuration>.
3. Contact Rating: [30-A inductive or resistive, 240-V ac] [20-A ballast load, 120-/240-V ac] <Insert rating>.
4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
5. Astronomic time dial.
6. Eight-Day Program: Uniquely programmable for each weekday and holidays.
7. Skip-a-day mode.
8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of [16] <Insert number> hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 1. Cooper Industries, Inc.

2. Intermatic, Inc.
 3. NSi Industries LLC; TORK Products.
 4. Tyco Electronics; ALR Brand.
 5. **<Insert manufacturer's name>.**
- C. Description: Solid state, with **[SPST] [DPST]** dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range.
 3. Time Delay: Thirty-second minimum, to prevent false operation.
 4. Lightning Arrester: Air-gap type.
 5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.3 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **[product indicated on Drawings]** **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lightolier Controls.
 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 7. Lutron Electronics Co., Inc.
 8. NSi Industries LLC; TORK Products.
 9. RAB Lighting.
 10. Sensor Switch, Inc.
 11. Square D; a brand of Schneider Electric.
 12. Watt Stopper.
 13. **<Insert manufacturer's name>.**
- C. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.

- c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 7. Bypass Switch: Override the "on" function in case of sensor failure.
 - 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
- D. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
- 1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 - 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
- E. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
- 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
- F. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
- 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **[product indicated on Drawings]** <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Leviton Mfg. Company Inc.
5. Lightolier Controls.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; TORK Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D; a brand of Schneider Electric.
12. Watt Stopper.
13. **<Insert manufacturer's name>.**

C. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application[, **and shall comply with California Title 24**].
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

D. Wall-Switch Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of **[900 sq. ft. (84 sq. m)] [2100 sq. ft (196 sq. m)]**.
2. Sensing Technology: **[PIR] [Dual technology - PIR and ultrasonic]**.
3. Switch Type: **[SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."] [SP, field selectable automatic "on," or manual "on" automatic "off."]**
4. Voltage: **[Match the circuit voltage] [120 V] [277 V] [Dual voltage, 120 and 277 V]; [passive-infrared] [dual-technology]** type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

E. Wall-Switch Sensor Tag WS2:

1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: PIR.
3. Switch Type: **[SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."] [SP, field selectable automatic "on," or manual "on" automatic "off."]**
4. Voltage: **[Match the circuit voltage] [120 V] [277 V] [Dual voltage, 120 and 277 V]; [passive-infrared] [dual-technology]** type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.5 OUTDOOR MOTION SENSORS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **[product indicated on Drawings]** **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 6. NSi Industries LLC; TORK Products.
 7. RAB Lighting.
 8. Sensor Switch, Inc.
 9. Watt Stopper.
 10. **<Insert manufacturer's name>**.
- C. General Requirements for Sensors: Solid-state outdoor motion sensors.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application[, **and shall comply with California Title 24**].
 2. **[PIR] [Dual-technology (PIR and infrared)]** type, weatherproof. Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm). Comply with UL 773A.
 3. Switch Rating:
 - a. Lighting-Fixture-Mounted Sensor: **[1000-W incandescent, 500-VA fluorescent] <Insert rating>**.
 - b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 4. Switch Type: **[SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."][SP, field selectable automatic "on," or manual "on" automatic "off."][~~ds~~-With bypass switch to override the "on" function in case of sensor failure.]**
 5. Voltage: **[Match the circuit voltage] [120-V] [277-V] [Dual voltage, 120- and 277-V]** type.
 6. Detector Coverage:
 - a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
 - b. Long Range: 180-degree field of view and 110-foot (34-m) detection range.
 - c. **<Insert coverage area>**.
 7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 9. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
 10. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
 11. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as "raintight" according to UL 773A.

2.6 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **[product indicated on Drawings]** **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. Allen-Bradley/Rockwell Automation.
 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 3. Eaton Corporation.
 4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
 5. Square D; a brand of Schneider Electric.
 6. **<Insert manufacturer's name>.**
- C. Description: Electrically operated and **[mechanically] [electrically]** held, combination-type lighting contactors with **[fusible switch] [nonfused disconnect]**, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as **[indicated on Drawings] [scheduled]**, matching the NEMA type specified for the enclosure.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than **[No. 18] [No. 22] [No. 24]** AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than **[No. 14] [No. 16] [No. 18]** AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. Occupancy Adjustments: When requested within **[12] <Insert number>** months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to **[two] <Insert number>** visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
- C. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.
- D. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- E. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:
 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

SECTION 262726 WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Weather-resistant receptacles.
 - 3. Snap switches and wall-box dimmers.
 - 4. Solid-state fan speed controls.
 - 5. Wall-switch and exterior occupancy sensors.
 - 6. Communications outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Products: Subject to compliance with requirements provide one of the following, but are not limited to, the following:
 - 2. Cooper; VGF20.
 - a. Hubbell; GFR5352L.
 - b. Pass & Seymour; 2095.
 - c. Leviton; 7590.

2.5 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:
 - 2. Single Pole:
 - 1) Cooper; AH1221.

- 2) Hubbell; HBL1221.
- 3) Leviton; 1221-2.
- 4) Pass & Seymour; CSB20AC1.

- 5) Two Pole:

- 6) Cooper; AH1222.
- 7) Hubbell; HBL1222.
- 8) Leviton; 1222-2.
- 9) Pass & Seymour; CSB20AC2.

- 10) Three Way:

- 11) Cooper; AH1223.
- 12) Hubbell; HBL1223.
- 13) Leviton; 1223-2.
- 14) Pass & Seymour; CSB20AC3.

- 15) Four Way:

- 16) Cooper; AH1224.
- 17) Hubbell; HBL1224.
- 18) Leviton; 1224-2.
- 19) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:

2. Cooper; AH1221PL for 120 and 277 V.
 - a. Hubbell; HBL1201PL for 120 and 277 V.
 - b. Leviton; 1221-LH1.
 - c. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.

3. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:

2. Cooper; AH1221L.
 - a. Hubbell; HBL1221L.
 - b. Leviton; 1221-2L.
 - c. Pass & Seymour; PS20AC1-L.

3. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.6 DECORATOR-STYLE DEVICES

- A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:
 2. Cooper; 6252.
 - a. Hubbell; DR15.
 - b. Leviton; 16252.
 - c. Pass & Seymour; 26252.
- B. GFCI, [**Feed**] [**Non-Feed**]-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:
 2. Cooper; VGF15.
 - a. Hubbell; GF15LA.
 - b. Leviton; 8599.
 - c. Pass & Seymour; 1594.
- C. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:
 2. Cooper; 7621 (single pole), 7623 (three way).
 - a. Hubbell; DS115 (single pole), DS315 (three way).
 - b. Leviton; 56291-2 (single pole), 5623-2 (three way).
 - c. Pass & Seymour; 2621 (single pole), 2623 (three way).
- D. Lighted Toggle Switches, Square Face, 120 V, 15 A: Comply with NEMA WD 1 and UL 20.
1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:
 2. Cooper; 7631 (single pole), 7633 (three way).
 - a. Hubbell; DS120IL (single pole), DS320 (three way).
 - b. Leviton; 5631-2 (single pole), 5633-2 (three way).
 - c. Pass & Seymour; 2625 (single pole), 2626 (three way).
 3. Description: With neon-lighted handle, illuminated when switch is "off."

2.7 RESIDENTIAL DEVICES

- A. Fan Speed Controls:
1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
 2. Comply with UL 1917.
 3. Continuously adjustable rotary knob, [5 A
 4. Three-speed adjustable rotary knob, 1.5 A.
- B. Telephone Outlet:
1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:

2. Cooper; 3560-6.
 - a. Leviton; 40649.
 - b. Hubbell
3. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.

C. Combination TV and Telephone Outlet:

1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:
2. Cooper; 3562.
 - a. Leviton; 40159.
 - b. Hubbell
3. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.

2.8 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 1. 600 W; dimmers shall require no derating when ganged with other devices.
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.9 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: Type 302 stainless steel] [0.04-inch- thick.
 3. Material for Unfinished Spaces: Galvanized steel.
 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.10 FINISHES

- A. Device Color:
 1. Wiring Devices Connected to Normal Power System As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System: Red.
 3. TVSS Devices: Blue.

- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

SECTION 265100 INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior lighting fixtures, lamps, and ballasts.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
 - 5. Retrofit kits for fluorescent lighting fixtures.

- B. Related Sections:
 - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
 - 2. Section 260933 "Central Dimming Controls" for architectural dimming systems.
 - 3. Section 260943.13 "Addressable-Fixture Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
 - 4. Section 262726 "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
 - 5. Section 265561 "Theatrical Lighting" for theatrical lighting fixtures and their controls.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.

- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, [provide product indicated on Drawings, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- G. 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.
- H. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
- I. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Section 233713 "Diffusers, Registers, and Grilles."
 - 1. Air-Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
 - 2. Heat-Removal Units: Air path leads through lamp cavity.
 - 3. Combination Heat-Removal and Air-Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air-supply units.
 - 4. Dampers: Operable from outside fixture for control of return-air volume.
 - 5. Static Fixture: Air-supply slots are blanked off, and fixture appearance matches active units.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. General Requirements for Electronic Ballasts:
 - 1. Comply with UL 935 and with ANSI C82.11.
 - 2. Designed for type and quantity of lamps served.
 - 3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
 - 4. Sound Rating: Class A.
 - 5. Total Harmonic Distortion Rating: Less than [10] [20] percent.
 - 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - 7. Operating Frequency: 42 kHz or higher.
 - 8. Lamp Current Crest Factor: 1.7 or less.

9. BF: 0.88 or higher.
 10. Power Factor: 0.95 or higher.
- B. luminaires controlled by occupancy sensors shall have programmed-start ballasts.
- C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
1. Ballast Manufacturer Certification: Indicated by label.
- D. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
- E. Ballasts for Low-Temperature Environments: Electronic type rated for 0 deg F starting and operating temperature with indicated lamp types.
- F. Ballasts for Residential Applications: Fixtures designated as "Residential" may use low-power-factor electronic ballasts having a Class B sound rating and total harmonic distortion of approximately 30 percent.
- G. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
 4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.
- H. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 30 percent of rated lamp lumens.
 2. Ballast shall provide equal current to each lamp in each operating mode.
 3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.
- I. Ballasts for Tri-Level Controlled Lighting Fixtures: Electronic type.
1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 30 and 50 percent of rated lamp lumens.
 2. Ballast shall provide equal current to each lamp in each operating mode.
 3. Compatibility: Certified by manufacturer for use with specific tri-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: Class A.
 4. Total Harmonic Distortion Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.95 or higher unless otherwise indicated.
 9. Power Factor: 0.95 or higher.
 10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 EMERGENCY FLUORESCENT POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
1. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of **1100** lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Nightlight Connection: Operate one fluorescent lamp continuously.
 3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 4. Battery: Sealed, maintenance-free, nickel-cadmium type.
 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is announced by an integral audible alarm and a flashing red LED.

2.6 BALLASTS FOR HID LAMPS

- A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
 3. Rated Ambient Operating Temperature: 104 deg F .
 4. Open-circuit operation that will not reduce average life.
 5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.
- B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Minimum Starting Temperature: Minus 20 deg F (Minus 29 deg C) for single-lamp ballasts.
 2. Rated Ambient Operating Temperature: 130 deg F (54 deg C).
 3. Lamp end-of-life detection and shutdown circuit.
 4. Sound Rating: Class A.
 5. Total Harmonic Distortion Rating: Less than 20 percent.
 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 7. Lamp Current Crest Factor: 1.5 or less.
 8. Power Factor: 0.90 or higher.
 9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 10. Protection: Class P thermal cutout.
- C. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
 2. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

2.7 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
 2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. 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. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.8 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay

- disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

2.9 FLUORESCENT LAMPS

- A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life 42,000 hours unless otherwise indicated.
- B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.
- C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 4100 K, average rated life of 10,000 hours at three hours operation per start, and suitable for use with dimming ballasts unless otherwise indicated.
 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
 6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).
 7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

2.10 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.11 RETROFIT KITS FOR FLUORESCENT LIGHTING FIXTURES

- A. Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces.

- B. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.
- E. Adjust aimable lighting fixtures to provide required light intensities.
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION

**SECTION 270710
TELECOMMUNICATIONS GENERAL REQUIREMENTS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Scope of Work
- B. Codes and Specifications
- C. General Requirements and Conditions
- D. Product Requirements
- E. Structured Cabling System
- F. Submittals
- G. Record Drawings
- H. Definitions

1.2 RELATED SECTIONS

- A. Section 270715 - Acceptance Testing
- B. Section 270720 - Basic Materials and Methods
- C. Section 270725 - Telecommunications Cable
- D. Section 270760 - Telecommunications Grounding and Bonding

1.3 SCOPE

- A. General Scope
 - 1. The scope of work includes the provision, installation, testing and documentation of physical resources for voice and data systems required by the construction documents for the core renovation of buildings E and T. The work shall include new telecommunications outlets, category 6 horizontal cables from outlets to telecommunications rooms All cabling systems shall be installed by certified technicians under the University Standard, structured cabling systems. All labor and materials shall be covered by manufacturers' extended warranties.
 - 2. The Contractor shall provide all labor, materials, tools, equipment and permits necessary for the satisfactory and timely completion of the project.
 - 3. The Contractor and University Architectural Team shall jointly coordinate the implementation of the project.
- B. Statement of Work

1. The work includes, but is not limited to, the items outlined in these specifications and indicated on the drawings, as well as all incidental items required to provide complete and operable systems. The Contractor, the Engineer of Record, the University, and the University Team shall mutually agree on the general conduct for the work prior to initiation of construction and shall each be responsible for following these general guidelines throughout the construction period unless modified in writing based upon discussions at the project coordination meetings. The Contractor shall also be responsible for cutting over existing telecommunication services to the new cabling systems.

1.4 CODES AND SPECIFICATIONS

- A. All work shall be performed in compliance with the most restrictive of Municipal, State, and/or Federal Codes which may govern this work and shall conform to the following codes and specifications:

1. National Fire Protection Association
 - a. NFPA 70-2001 National Electric Code.
 - b. NFPA 258 - Standard Test Method for Measuring Smoke Generated by Solid Materials.
2. ANSI Specifications:
 - a. ANSI C2-1981 National Electrical Safety Code.
 - b. ANSI C80.3 Specification for Zinc-coated Electrical Metallic Tubing.
 - c. ANSI/UL 797 Electrical Metallic Tubing.
 - d. ANSI/ICEA S-83-596-1994 - Fiber Optic Premises Distribution Cable Technical Requirements.
3. Electronics Industry Alliance/Telecommunications Industry Association (EIA/TIA):
 - a. ANSI/EIA/TIA 568-B.1, B.2, B.3 - Commercial Building Telecommunications Wiring Standard. 2001
 - b. EIA/TIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces 1998 and Addendum #1 & 2, 2000.
 - c. EIA/TIA TSB 36 - Technical Systems Bulletin Additional Cable Specifications for Unshielded Twisted Pair Cables.
 - d. EIA/TIA TSB 67 - Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems.
 - e. EIA/TIA TSB 72 - Centralized Optical Fiber Cabling Guidelines.
 - f. EIA/TIA 75 – Additional Horizontal Cabling Practices for Open Offices.
 - g. EIA/TIA 606A - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

- h. EIA/TIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications. 1994
 - i. EIA - 310-D - Cabinets, Racks, Panels, and Associated Equipment.
 - j. EIA/TIA 526-14A - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
 - k. EIA/TIA 455-57A - Optical Fiber End Preparation and Examination.
 - l. EIA/TIA 455-59 - Measurement of Fiber Point Defects Using and OTDR.
 - m. EIA/TIA 455-60 - Measurement of Fiber Cable Length Using an OTDR.
 - n. EIA/TIA 455-61- Measurement of Fiber Cable Attenuation Using an OTDR.
 - o. EIA/TIA 455-95 - Absolute Optical Power Test for Optical Fibers and Cables.
 - p. EIA RS-458A Standard Optical Waveguide Fiber Material Classes and Preferred Sizes.
 - q. EIA-472 Generic Specification for Optical Waveguide Fibers.
4. Federal Communications Commission (FCC) Part 15 and Part 68.
 5. Title 24 - State of California Code of Regulations.
 6. 2001 California Building Code.
 7. 2001 California Electrical Code
 8. Occupational Safety and Health Administration (OSHA) Specifications.
 9. IEEE Specifications:
 - a. IEEE 802.2 Logical Link Control Working Group
 - b. IEEE 802.3 Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
 10. NEMA VE1 Cable Tray Systems.
 11. Underwriters Laboratories Specifications:
 - a. UL 497 Electrical Grounding and Bonding Equipment.
 - b. UL 1479 Fire Tests of Through-Penetration Firestops.
 - c. UL Building Materials Directory; Through-Penetration Firestops Systems, and Fill, Void or Cavity Materials.
 12. The California Mechanical Code.
 13. ASTM Specifications:

- a. ASTM E 814 Methods of Fire Tests of Through-Penetration Fire Stops.
 - b. ASTM E 136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.
14. Rural Utilities Services (RUS), Bulletin 345-63, RUS Specifications for Acceptance Tests and Measurements of Telephone Plant.
 15. Americans With Disabilities Act (ADA).
- B. Where reference is made to a requirement that exceeds minimum code requirements, the specification requirement shall take precedence. The Contractor and owner's representative shall jointly resolve any work that is in apparent conflict with applicable codes.
- C. When these specifications call for materials or construction of better quality or larger sizes than required by the above-mentioned rules and regulations, the provisions of these specifications shall take precedence.
- D. In accordance with these laws, rules, and regulations, the Contractor shall provide the following:
1. Any additional material and labor that may be required for compliance with these laws, rules, and regulations, even though the work is not mentioned in these particular specifications.
 2. All permits required by any of the legally constituted public authorities for the installation or construction of the work.
 3. Any inspection or examinations required. Copies of certificates of all such inspections shall be delivered to the owner's representative.
 4. If any work is concealed without proper inspection and approval, the Contractor shall be responsible for all work required opening and restoring the concealed areas, in addition to all required modifications.

1.5 GENERAL REQUIREMENTS AND CONDITIONS

A. Safety

1. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of persons and property during performance of work.
2. The Contractor shall ensure that all personnel working in or anywhere on the site shall be provided a hard hat, safety shoes, a face shield or safety goggles, etc. for their protection.
3. All personnel working in or anywhere on the site shall display a photo-ID.
4. The Contractor shall ensure that all personnel working in or anywhere on the site shall conform to the University's regulations regarding confined space.
5. No act, service, drawing review, or construction observance by owner's representative or any other party employed by the University is intended to include review or approval of adequacy of the Contractor's safety measures, in, on, or near the construction site.

B. Quality Assurance

1. The specifications contained herein are set forth as the minimum acceptable requirements of the Contractor's Quality Assurance program. The Contractor is responsible for executing any other Quality Assurance measures necessary to ensure complete and fully functioning systems within the scope of this project.
 2. The Contractor shall ensure that all design, workmanship, materials employed, required equipment, and the manner and method of installation conforms to accepted practices. Where specific specifications do not apply, the more stringent of industry publications, University policies, manufacturer's guidelines, or previous (similar) work at the project site shall apply.
 3. The Contractor shall also ensure that each piece of equipment is in satisfactory working condition.
 4. The Contractor shall certify that the cable manufacturers have carried out the quality assurance tests and procedures as specified herein. All cable must be manufactured by an ISO9001 Certified Manufacturer.
 5. The Contractor is responsible for ensuring that the cable packaging for shipping/storage purposes meets or exceeds the following requirements:
 - a. One continuous length of cable per shipping reel/container.
 - b. Reels must be wooden or steel, sturdy, lagged, and shall have thermal protection jackets applied prior to lagging.
 - c. Each reel/container shall be individually identified and marked with the length of the cable it contains. Said marking shall withstand weather and shipping conditions and remain readable.
 - d. For fiber optic cable, results of the 100% Attenuation tests conducted at the factory shall accompany each reel.
 - e. Cable shall be packed in a manner that facilitates the pre-installation tests to be conducted while the cable is still on the reel (i.e., both ends of the cable must be accessible while protected from moisture).
 - f. The Quality Assurance Plan employed shall include on-reel testing of fiber, and UTP, including, but not limited to, OTDR, power loss, attenuation, etc. (as applicable for given cable media).
- C. Manufacturer's Literature: Where these specifications call for an installation to be made in accordance with the manufacturer's recommendations, a copy of such recommendations shall always be kept on the job site and shall be available to owner's representative.
- D. Acceptance of Telecommunications Work
1. The Contractor must demonstrate successful completion of the following tasks for the University Team to accept the telecommunications work:
 - a. Before executing any performance testing, the Contractor shall present a test plan to the Academic Computing and Information Technology (ACIT) representative and the Engineer of Record for approval.

- b. The Contractor has completed all testing and delivered copies of all test results to the Engineer of Record.
 - c. All test results have been examined and approved by the University and Engineer of Record.
 - d. Copies of all documentation required by this section have been delivered to the Engineer of Record.
 - e. All punch list items are completed to the satisfaction of the project manager or Inspector of Record.
 - f. Structured Cabling System Certification is provided to the University.
2. Minor failures such as incomplete resolutions to punch list items shall be responded to at the University Team's discretion or within one business day.
 3. Following completion and/or compliance with the requirements listed above, the Contractor shall issue a Notice of Completion confirming that the project is complete. A 45-day acceptance period shall begin immediately following the issuance of the notice of Completion.

E. Guarantee and Warranties

1. The installed copper cables and all fiber optic cables must be installed by certified installers and covered under the University's Structured Cabling Systems. See paragraph 1.7.
2. The Contractor shall be responsible for correcting any problems and malfunctions that are warranty-related for the entire warranty period.
3. Copies of any extended material warranties shall be passed through to the owner's representative.
4. During the installation and up to the date of final acceptance, the Contractor shall protect all finished and unfinished work against damage and loss. In the event of such damage or loss, the Contractor shall replace or repair such work at no cost to the University.

1.6 PRODUCT REQUIREMENTS

A. General Information

1. These specifications identify the minimum specifications for product quality acceptable on this project by designating a manufacturer's trade or brand name and catalog or model number and by describing attributes, performance, or other specifications.
2. Where applicable, the most recent manufactured product line consistent with the structured cable system supplier identified in the technical specification sections is to be the minimum standard for quality and performance of products to be used on this project.
3. For any product described only by attributes, performance, or specifications, the Contractor shall develop a Product Submittal in accordance with the requirements set forth herein. All Product Submittals must be reviewed with owner's representative prior to their use and installation on the project. The Engineer of Record must approve all product submittals.

4. Such phrases as "or equal," "or equivalent," and "or acceptable substitute" indicate that an equivalent product may be proposed as a substitute for that which is specified. The proposed substitution must meet or exceed the attributes, performance, or other specifications of the specified product and must be approved by the owner's representative.
5. Failure of the Contractor to submit proposed substitutions for approval in the manner described above shall be sufficient cause for disapproval by the Engineer of Record of any substitutions otherwise proposed.
6. Physical samples may be required. If tests to determine equality and utility are required by the Engineer of Record, they shall be made by a testing laboratory with the acceptance of the test procedure first given by the Engineer of Record, at the expense of the Contractor.

B. Quality of Materials

1. All materials and equipment supplied by the Contractor shall be new, manufactured within one (1) year prior to installation, and meet or exceed the latest published specifications of the manufacturer. All material shall be acceptable to and approved by the University as meeting these specifications.
2. All communications materials used on this project shall conform, where applicable, to the following specifications, unless otherwise noted:
 - a. NEMA - National Electrical Manufacturers Association.
 - b. ANSI - American National Specifications Institute.
 - c. UL - Underwriters Laboratories, Inc.
 - d. The latest IEEE and EIA/TIA specifications.
3. Telephone system materials and equipment shall be FCC Type-accepted and certified as such by supplier.
4. No material employed shall present environmental or toxicological hazards as defined by current industry specifications. All materials shall comply with CAL OSHA and EPA specifications or applicable federal or state laws or regulations.
5. The equipment, apparatus, and material for fiber optic equipment and apparatus shall conform to existing CAL OSHA health and safety laws. The equipment and apparatus shall have provision for application of safety labels, such as LASER identification, or warning labels as required by system considerations.

C. Materials Delivery and Storage

1. Costs of all shipping to the site, inside handling, and all unusual storage requirements shall be borne by the Contractor.
2. The Contractor shall make appropriate arrangements and coordinate with authorized personnel at the site for the proper acceptance, handling, protection, and storage of materials so delivered.
3. All materials delivered to the site shall be received, handled and stored by employees of the contractor.

1.7 STRUCTURED CABLING SYSTEM

A. General: All telecommunications cables for the voice and data systems shall be installed under the University standard structured cabling systems. The only acceptable systems are listed below for each type of cable network.

B. Hubbell Premise Wiring® Structured Cabling System (University Standard)

The horizontal, Category 6, copper station cables and terminating equipment shall be installed by a certified Contractor under the Hubbell Premise Wiring® Structured Cabling System and covered by a 20 year warranty for materials and labor.

C. The installed fiber cables and terminating equipment shall be installed by a certified Contractor under the Hubbell Premise Wiring Warranty Program and covered by a 20 year warranty for materials and labor.

1.8 SUBMITTALS

A. Structured Cabling System Pre-Qualification Certificate: The Contractor shall submit a letter of approval from the manufacturers indicating completion of pre-qualification requirements for installation of the Structured Cabling Systems. Documentation shall include training certificates for installation of the proposed products. These documents shall be submitted for approval with the first telecommunications product submittals.

B. Shop Drawings and Supplemental Data

1. Copies of shop drawings and supplemental data shall be provided for the engineer's review. Shop drawings shall be submitted for all communications equipment, cabling, and structure pertaining to the job (distribution frames, conduit, wire, fiber optic cable, terminations, splices, etc.)

2. Design submittals (reflecting field conditions, actual cable lengths, equipment elevations, and performance expectations) shall be prepared for each system included in the project scope and reviewed with Engineer of Record.

3. Copies of final shop drawings and supplemental data, where called for, shall be submitted to the Engineer of Record. Final corrected copies of schedules and shop drawings or supplemental data shall be as follows (exceptions shall be noted in Specification Sections):

a. One (1) for the Telecommunications Master Plan Engineer's files.

b. Two (1) for University

c. One (1) to the Contractor's job files and additional copies as the Contractor may desire for office files and/or for distribution to subcontractors or vendors.

4. The shop drawings and supplemental data called for shall be submitted as the instruments of the Contractor, even though they may have been prepared by a subcontractor, supplier, dealer, manufacturer, or by any other person, firm, or organization. Prior to submission, the Contractor shall conduct a review and stamp with acceptance and then submit to Engineer of Record for final review. By accepting and submitting shop drawings and supplemental data, the Contractor has determined and verified all field measurements, the physical construction, the quality of materials, the applicability of catalog numbers, and similar data. The Contractor has also checked and coordinated each shop drawing with the requirements

of the field conditions and resolved conflicts between trades prior to the actual construction.

5. All shop drawings shall be drawn accurately on paper suitable for duplicate copying by black, blue line printing processes or Xerox.
6. Supplemental data shall include information as noted in the specification paragraphs requiring them.
7. The University Team and Engineer of Record will review shop drawings and supplemental data submitted by the Contractor only for general design conformance with the concept of the project and compliance with the information given in the Contract Documents. A review status of "No Exceptions Taken" on a submittal does not relieve the contractor of the requirements to comply with building codes or the contract specifications."
8. Shop drawings shall be submitted for review and approval by the University Team and Engineer of Record prior to use on the job.
9. Shop drawings delineation: The shop drawings shall be drawn to scale and shall be completely dimensioned, giving the plan together with such sections as are necessary to clearly show construction detail.
10. Responsibility
 - a. The Contractor or Contractor's suppliers shall prepare the shop drawings and all supporting data, catalogs, etc. The Contractor shall check all drawings before submission.
 - b. In particular, the Contractor shall insure that the drawings meet all requirements of the drawings and specifications and also conform to the structural and space conditions.
 - c. Each shop drawing submitted for University approval shall bear a stamp certifying that the Contractor in accordance with the specifications has checked it. If such shop drawings show variations from Contract Documents, whether because of standard shop practice or other reasons, the Contractor shall make special mention thereof in the transmittal letter.
 - d. The Contractor shall be fully responsible for observing the need for and making any changes in the arrangement of piping, connections, wiring, manner of installation etc. that may be required by the proposed equipment to accommodate any work affected under other parts, headings, or divisions of Drawings and Specifications.
11. Identification: Shop drawings shall be titled with the name of the project on each sheet and shall otherwise be identified by listing the particular division, section, article or reference of the work to which they pertain. Different items shall be submitted on separate sheets, and all submittals shall be numbered serially.
12. Manner: The Contractor shall furnish separate submittal sheets for each specialty item for engineer of records approval in the following manner:
 - a. Five (8) copies of catalog cuts shall be submitted. The cut sheets shall be photocopied or reproduced in some other acceptable manner on one side only of an 8 1/2" x 11" sheet, noting only the items in question, together with the descriptive (specification) data. Drawings shall be submitted in ozalid transparency form.

- b. Each sheet shall be identified with the division, section, article or reference in the Contract Documents that covers the item submitted for approval.
- c. Each sheet shall be identified with the project name.
- d. Each sheet shall bear the Contractor's stamp and signature of approval.

1.9 RECORD DRAWINGS

- A. The Contractor shall keep one set of drawings on site to continually maintain an accurate record of the as-constructed work.
- B. The marked-up drawings shall accurately indicate location of equipment, pull-boxes, conduits, cable types and labeling.
- C. Within 30 days of completing work, the Contractor shall submit five (5) copies of as-built drawings to the owner's representative. In addition, the Contractor shall provide an electronic copy of the as-built drawings in a format specified (Auto CAD 14 or Higher) by the owner's representative.

1.10 DEFINITIONS

- A. Backboard: Backboard generally refers to the A-C, fire-retardant, plywood sheeting lining the walls of the telecommunications facilities. Backboards may also refer to the entire wall-mounted assembly, including wire management and termination frames.
- B. Building Distribution Frame (BDF): The BDF is the location within a building where the entire inside cable and fiber optic plant originates. The entire cable and fiber optic entrance facilities also terminate here. Part of the Horizontal Distribution System may originate here as well. It may include: the physical location, enclosure, wire and copper cable management hardware, fiber and management hardware, termination hardware, distribution hardware, protection hardware, active electronic components, and equipment racks. EIA/TIA-569 "Commercial Building Standard for Telecommunications Pathways and Spaces" refers to the room housing the BDF as the Equipment Room. Throughout this specification, BDF and Telecommunications Equipment Room are equivalent.
- C. CATV: Cable Antenna Television system.
- D. Cable Plant: Cable, conduit raceways, vaults, junction/pull boxes, rooms, racks, equipment, patch bays/blocks, and other infrastructure required to provide physical, electrical, optical connectivity between buildings on the University.
- E. Cable Rack: Hardware designed and manufactured for horizontal pathway distribution of cable and inside wiring inside the MDF, BDF, or IDF rooms.
- F. Cable Tray: Hardware designed and manufactured for horizontal pathway distribution of cable and inside wire from the MDF, BDF, or IDF to the Information Outlet access point.
- G. Copper Entrance Cable: Copper Cable that joins the University's backbone infrastructure at its connecting point to the buildings BDF.
- H. Designation Strips: Paper or plastic strips, usually contained in a clear or color tinted plastic carrier, designated for insertion into a termination frame. Designation strips are usually imprinted with the adjacent terminal number and are used to aid in locating a specific pair, group of pairs, or information outlet inserted into the termination frame, or for the purpose of delineating a

termination field.

- I. Entrance Conduit: Conduit that connects the University's underground infrastructure with the building's BDF.
- J. Fiber Entrance Cable: Fiber Optic cable that joins the University's backbone infrastructure at its connecting point to the buildings BDF.
- K. Horizontal cables: Cables linking the information outlets with the IDF or BDF.
- L. Information Outlet: An integral assembly containing one of the following:
 - 1. The standard outlet used for voice and data services will consist of three, 4 pair category 6 jacks that can be used for various services (voice, data, network, etc.).
 - 2. The standard outlet for voice telephone service will consist of one, 4 pair category 6, jack mounted in wall phone faceplate.
 - 3. The category 6 jacks shall be mounted in faceplates that are secured to standard metal electrical outlet boxes or non-metallic communications surface mounted boxes. Blank dust cover(s) shall be provided in the unused faceplate positions.
- M. Inside Plant (ISP): Communications system inside a building (wire, fiber, coaxial cable, equipment and racks, information outlets, etc.).
- N. Intermediate Distribution Frame (IDF): The IDF is the location in a building where a transition between the Riser System and the Horizontal Distribution System occurs. It may include: the physical location, enclosure, wire and cable management hardware, fiber and management hardware, active electronic components, termination hardware, and equipment racks. EIA/TIA-569-A, "Commercial Building Specifications for Telecommunications Pathways and Spaces" refers to the IDF as the Telecommunications Closet. Throughout this specification IDF and Telecommunications Closet/Room are equivalent.
- O. LAN: Local Area Network.
- P. Building Distribution Frame (BDF): The BDF is the location, within a building, where the entire outside copper cable and fiber optic plant terminates. It may include the physical location, enclosure, wire, fiber, and copper cable hardware, protection, active electronic components, equipment frames and racks. EIA/TIA –569-A "Commercial Building Standard for Telecommunications Pathways and Spaces": refers to the room housing the BDF as the Equipment Room.
- Q. MPOE: Minimum Point of Entry, Utility Partnerships/Alternate Carrier, located within the MDF.
- R. Management Hardware
 - 1. Fiber Management: Hardware designed and manufactured for the purpose of keeping fiber patch cords neat and orderly. Most termination frame manufacturers provide fiber management components designed to work in conjunction with their termination frames. Fiber management may also refer to other types of hardware for the purpose of securing fiber optic cable to the building.
 - 2. Wire Management (Copper, Data, Network): Hardware designed and manufactured for the purpose of keeping cross-connect wire and patch cables neat and orderly. Most

termination frame manufacturers provide wire management components designed to work in conjunction with their termination frames. Wire management may also refer to other types of hardware for the purpose of securing wire and cable to the building.

- S. Outside Plant (OSP): Communications system outside of the buildings (typically underground conduit and vaults, exterior/underground, aerial, and buried rated wire and cable, etc.).
 - T. Provide: Supply, furnish, deliver, install, terminate, label, test, ground and document the components per these specifications.
 - U. Riser Cable: High volume cable (copper) that connects the BDF with the IDF or backboards located on the same or different floors.
 - V. Riser Conduit: Conduit that connects the BDF to the IDF or backboards located on the same or different floors.
 - W. Riser Fiber Cable: Fiber Optic Cables that connects the BDF with IDF or backboards located on the same or different floors.
 - X. SPOE: Secondary Point of Entry, Utility/Alternate Carrier Partnership in buildings other than the MDF.
 - Y. Station Wire: 4 pair, unshielded, twisted pair, category 6 wire that connects the information outlet to the BDF or IDF.
 - Z. Telecommunications Ground: An electrical ground (as defined by local codes), usually the main building ground electrode extended by a continuous AWG "3/0" wire to ground bus bars in the BDF, IDF, and roof telecommunications terminal point.
- AA. Termination Fields
- 1. Copper, Data, Network Termination Fields: A group of termination frames clustered together to provide terminations for specific cable or inside wiring groups, where all of the cable or wiring in the group is used for a single purpose, constitutes a copper, data, or network termination field. The extent of a specific field, located in a group of fields, may be distinguished by a physical separation between the frames forming the field, by uniquely colored designation strips, or by a series of terminal numbers.
 - 2. Fiber Optic Termination Fields: A group of termination frames clustered together to provide terminations for fiber optic cable fibers, where all of the cable fibers are used for a single purpose, constitutes a fiber termination field.
- BB. Termination Frames
- 1. Copper Termination Frame: Device designed and manufactured for the purpose of terminating large numbers of copper cable or station wire pairs. These devices generally utilize insulation displacement connections and usually require special tools to make the terminations. Throughout this specification, the terms Copper Termination Frame and Wiring Block are equivalent.
 - 2. Data Termination Frame: Device designed and manufactured for the purpose of terminating copper cable pairs from the active data electronic hardware. These devices generally utilize insulation displacement connections and usually require special tools to make the terminations. Throughout this specification, the terms Data Termination Frame and/or Data

Patch Panel are equivalent.

3. Fiber Termination Frame: Device designed and manufactured for the purpose of terminating fiber optic cable fibers into "LC" connector field.
4. Network Termination Frame: Device designed and manufactured for the purpose of terminating copper cable pairs from the active data electronic hardware. These devices generally utilize insulation displacement connections and usually require special tools to make the terminations. Throughout this specification, the terms Network Termination Frame and Network Jack Panel are equivalent.

PART 2 - MATERIALS

Not used

PART 3 - EXECUTION

3.1 SEISMIC REQUIREMENTS

GENERAL:

- A. Earthquake-resistive design shall comply with the requirements of the 2009 California Building Code (CBC).
- B. Equipment and piping shall be braced in accordance with the most current edition of Seismic Restraint Manual Guidelines for Mechanical Systems (SMACNA) with Addendum No. 1 and National Uniform Seismic Installation Guidelines (NUSIG).

END OF SECTION

SECTION 270715 TELECOMMUNICATIONS ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing Publications and Standards
- B. Inspection and testing procedures for copper cables and fiber optic cables
- C. Documentation and As-Built Requirements

1.2 PUBLICATIONS AND STANDARDS

- A. Electronics Industry Alliance/Telecommunications Industry Association (EIA/TIA)
 - 1. ANSI/EIA/TIA 568-B.1, B.2, B.3 – Commercial Building Telecommunications Wiring Standard.
 - 2. EIA/TIA 569 – Commercial Building Standard for Telecommunications Pathways and Spaces
 - 3. EIA/TIA TSB 36 – Technical Systems Bulletin Additional Cable Specifications for Unshielded Twisted Pair Cables
 - 4. EIA/TIA TSB 40A – Additional Transmission Specifications for Unshielded Twisted-Pair Connecting Hardware
 - 5. EIA/TIA TSB 67 – Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems.
 - 6. EIA/TIA TSB 72 – Centralized Optical Fiber Cabling Guidelines
 - 7. EIA/TIA 606A – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - 8. EIA/TIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications
 - 9. EIA – 310-D – Cabinets, Racks, Panels, and Associated Equipment
 - 10. EIA/TIA-455-57A – Optical Fiber End Preparation and Examination
 - 11. EIA/TIA 455-59 – Measurement of Fiber Point Defects Using An OTDR
 - 12. EIA/TIA 455-60 – Measurement of Fiber or Cable Length Using An OTDR
 - 13. EIA/TIA 455-61 – Measurement of Fiber or Cable Attenuation Using An OTDR
 - 14. EIA/TIA 455-95 – Absolute Optical Power Test for Optical Fibers and Cables

15. EIA/TIA 526-14 – Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 16. ANSI/ICEA S-83-596-1994 – Fiber Optic Premises Distribution Cable Technical Requirements
- B. Federal Communications Commission (FCC) part 15 and part 68
 - C. Rural Utilities Services (RUS), Bulletin 345-63, RUS Standards for Acceptance Tests and Measurements of Telephone Plant.
- 1.3 RELATED SECTIONS
- A. Section 270710 - Telecommunications General Requirements
 - B. Section 270720 - Telecommunications Basic Materials and Methods
 - C. Section 270725 - Telecommunications Cable
 - D. Section 270760 - Telecommunications Grounding and Bonding

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 GENERAL PROCEDURES

- A. The Contractor will provide all tools, equipment, and fully trained staff necessary to conduct fully witnessed acceptance testing of all installed telecommunications-related products and systems.
- B. The Contractor shall prepare a complete test plan for all installed telecommunications systems for review and approval by the University Team and the Engineer of Record. The plan shall show, at a minimum, test configurations, calibration procedures, impedances, and measurement equipment. The scope of this work includes, but is not limited to, the following:
 1. All system(s) shall be checked for compliance with these specifications.
 2. The Contractor shall maintain a check-off list for University's reference during tests.
 3. The result of the measurements outlined shall be recorded and submitted along with current as-built drawings to the owner's representative as final proof of system performance.
 4. The Contractor shall expeditiously replace any system not meeting specifications at no cost to the University. Failure to act in an expeditious manner to properly remedy any abnormality resulting from installation/construction defects or workmanship; faulty material; and/or the failure of the systems, components, or the cable medium to perform in accordance with the University and/or Manufacturer's technical specifications shall cause the University to place a "hold" on any other telecommunications development or construction associated with this project. The owner's representative will notify the

Contractor in writing of such action and is absolved and shall be held harmless from any delays, costs over-runs, scheduling difficulties, etc. assessed by others due to the Contractor's failure to meet the final proof of system performance specifications. Final as built will be provided, as specified, at the end of the project.

5. All systems shall meet the bid specifications and be accepted by the University Team representative before the work will be considered complete.
- C. After the Contractor has provided complete documentation of all testing and the documentation have been reviewed by the owner's representative, the Contractor shall conduct "proof of performance" testing on selected components at the direction and discretion of the owner's representative. Such testing will utilize the same equipment and procedures used to conduct and document the initial tests but will be applied on a random basis to verify the testing documentation. If in the judgment of the owner's representative, the proof-of-performance test results vary significantly from the acceptance test results, the Contractor shall continue with testing until cleared by the owner's representative.
- D. All test equipment shall be calibrated by a certified laboratory or by the manufacturer within the last six months, and such certification shall be submitted to the owner's representative prior to testing.
- E. The following test equipment shall be used for all copper and fiber optic cable testing:
 1. Copper tester: Fluke DSP-4300; Part # DSP-4300 – first year support Part # GOLD-DSP-4300
 2. Fluke Optifiber certifying OTDR; Part # OF-500-30 – First year support Part # GLD-OF-50030-X
- F. All testing shall be coordinated with the owner's representative (providing a minimum of one week's notice) to ensure all acceptances and qualified personnel can witness proof-of-performance testing.
- G. A representative of the District ACIT Department shall be present during all fiber optic cable testing.

3.2 INSPECTION AND TESTING PROCEDURES FOR COPPER CABLE

- A. The owner's representative will conduct routine inspections of the work in progress, and any deficiencies will be discussed at the regular progress meeting. In the event the owner's representative determines work is progressing in an incorrect manner and waiting for the regular meeting could cause further problems, the Contractor's on-site project manager will be notified.
- B. Copper Station and Riser Cables: The Contractor shall conduct witnessed acceptance testing on all station and riser cable installed as part of this project as defined below:
 1. The correct and continuous bonding of cable shields through all riser and tie cable splices will be verified. This test shall be conducted from the BDF prior to strapping shield grounds at splice or termination points.
 2. Each station cable and all riser cable pairs will be tested for crosses, opens, grounds, reversed and/or transposed pairs, shorts, foreign battery, continuity, and resistance (in ohms). All riser cable pairs shall be tested for loss in dB. All problems will be resolved and the cable re-tested to ensure compliance.

3. Using a Category 6 rated pair scanner or similar device, all copper station cables shall be tested to verify the installation meets the EIA/TIA Category 6 performance specifications as defined in TSB-40A and TSB 67. All test results, including jack numbers, shall be printed on a hardcopy report. All stations shall meet or exceed this performance standard.
4. All pair scanners used on the project shall be calibrated to a single common test cable at the start of each shift and after changing batteries. The hardcopy of the calibration results shall be included as a reference with each batch of station test results submitted.

3.3 INSPECTION AND TESTING PROCEDURES FIBER CABLE

- A. University project staff will conduct routine inspections of the fiber optic cable installation process, and any deficiencies will be discussed at the regular progress meeting. In the event University project staff determines work is progressing in an incorrect manner and waiting for the regular meeting could cause further problems, the Contractor's on-site project manager will be immediately notified.
- B. The Contractor shall conduct witnessed acceptance testing on all fiber optic cables installed as part of this project as defined below:
 1. OTDR and power meter tests shall be performed on the fiber OSP cable between patch panels in BDF room in the building to the MDF Building in accordance with the field test specifications defined by the ANSI/TIA/EIA-568-B.
 2. ANSI/TIA/EIA-568-B, defines the passive cabling network, to include cable, connectors, and splices (if present), between two optical fiber patch panels (connecting hardware). A typical horizontal link segment is from the telecommunications outlet/connector to the horizontal cross-connect. The TIA document describes three typical backbone link segments: (1) main cross-connect to intermediate cross-connect, (2) main cross-connect to horizontal cross-connect, or (3) intermediate cross-connect to horizontal cross-connect. The test shall include the representative connector performance at the connecting hardware associated with the mating of patch cords. The test does not, however, include the performance of the connector at the interface with the test equipment.
 3. 100% of the installed cabling links shall be tested and must pass the requirements of the standards mentioned above. Any failing link shall be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the test for all links shall be provided in the test results documentation.
 4. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
 - a. The manufacturer of the fiber optic cable and/or fiber optic connectors.
 - b. The manufacturer of the test equipment used for the field certification.
 - c. Training organizations authorized by Building Industry Consulting Services International (BICSI).
 - d. Training organizations authorized by the Association of Cabling Professionals (ACP).

5. Field test instruments for multimode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-14A. The light source shall meet the launch requirements of ANSI/TIA/EIA-455-50B, Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-B.1) with a Category 1 light source.
6. Field test instruments for singlemode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-7.
7. The test equipment shall be within the calibration period recommended by the manufacturer in order to achieve the manufacturer's specified measurement accuracy. A copy of the calibration record(s) shall be included as a reference with each batch of fiber optic cable test results submitted.
8. The fiber optic launch cables and adapters must be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the test equipment interface adapters.
9. The Pass or Fail condition for the link under test is determined by the results of the required individual tests.
10. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.

3.4 DOCUMENTATION

A. Fiber Cable Systems

1. All documentation shall be neatly and legibly done and shall provide a clear understanding of the installed system.
2. The Contractor shall prepare "as-built" plans of all work including interbuilding and entrance cable locations with footage. All approved changes and actual in-place footage shall be marked, in red, on full size drawing. The as-built drawing shall include all fiber optic cable placed with cable lengths, fiber assignments, and cable numbers and counts.
3. The Contractor shall provide signed originals of all acceptance testing documents, which are:
 - a. Complete Fiber optic insertion loss results on CD in a format approved by the University.
 - b. Written summary of OTDR graphs and printouts and test results in a 3-ring binder.
 - c. Current test equipment certifications

B. Copper Cable Systems

1. The Contractor shall provide on CD complete testing results in a format recommended by the Structured Cabling System manufacturer and approved by the University. Document shall include the successful testing of all station cables. The Contractor shall also provide the software required to read the electronic records.

2. The Contractor is to provide a written summary of the Pass/Fail test results in a 3 ring binder.
3. Category 6 station cable test results noting unique station number and group test results by floor shall be provided in written summary.
4. The Contractor shall neatly note floor plans with "as-built" station number and any changes, additions, or deletions to outlet placement.

END OF SECTION

SECTION 270720
TELECOMMUNICATIONS BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit
- B. Conduit Supports
- C. Hangers and Cable Ties
- D. Surface Raceways
- E. Intrabuilding Cable Tags And Splice Case Labels
- F. Labels
- G. Station Outlets
- H. Faceplates
- I. Copper Cable Termination Blocks
- J. Data Network Patch Panels

1.2 RELATED SECTIONS

- A. Section 270710 – Telecommunications General Requirements
- B. Section 270715 – Telecommunications Acceptance Testing
- C. Section 270725 – Telecommunications Cable
- D. Section 270760 – Telecommunications Grounding and Bonding

1.3 APPLICABLE PUBLICATIONS

- A. As defined in Section 270710 – Telecommunications General Requirements.

1.4 SUBMITTALS

Contractor shall comply with requirements of Section 01300. Contractor shall provide submittals for all listed products in paragraph 1.01.

PART 2 – MATERIALS

The Contractor shall install materials and equipment as part of the University's Structured Cabling System Solutions as defined in paragraph 1.7 of specification 16710. Various sections of this specification pertain to specific products and/or installation requirements that must conform to the warranty requirements of these structured cabling systems.

2.1 CONDUIT

A. Rigid Steel Conduit

Rigid steel conduit shall comply with Underwriter's Laboratories UL-6 Specification, ANSI C80.1 and Federal specification WW-C-581E or latest revisions. Conduit shall be hot dip galvanized on the exterior, with zinc or enamel coating on the interior.

1. Manufacturer: Western Tube and Conduit, Allied Tube and Conduit, and Wheatland Tube Company, or approved equal.
2. Couplings, locknuts, and all other fittings shall be galvanized or sheardized, waterproof and threaded type only. Rigid conduit shall terminate with two locknuts – one outside and one inside enclosures and specified bushings. No running threads or chase nipples shall be used without approval.

Manufacturer: O-Z Gedney, Appleton, Crouse-Hinds or approved equal.

3. Bushings shall be non-metallic for 1 inch and smaller and insulated metallic for conduits larger than 1 inch.

Manufacturer: O-Z Gedney, Appleton, Crouse-Hinds or approved equal.

B. Electrical Metallic Tubing (EMT)

1. EMT conduit shall comply with Underwriter's Laboratories UL 797, ANSI C80.3 and Federal Specification WW-C-563 or latest revision. EMT shall be galvanized or sheardized.

Manufacturer: Western Tube and Conduit, Allied Tube and Conduit, and Wheatland Tube Company or approved equal.

2. Couplings and connectors for EMT shall be galvanized or cadmium plated and shall be of the compression type requiring the tightening of a nut on a gland ring. No die cast type shall be allowed. All connections shall have permanent insulated throats.

Manufacturer: O-Z Gedney, Appleton, Crouse-Hinds or approved equal.

- C. All communication conduits shall be equipped with a terminating bushing or collar to protect cables during placement.

- D. All station conduits shall be no smaller than one and one-quarter inch (1¼") in diameter unless otherwise noted.

2.2 CONDUIT SUPPORTS

- A. Pipe hangers for individual conduits shall be factory made, consisting of a pipe ring and threaded suspension rod. The pipe ring shall be malleable iron, split and hinged, or shall be interlocked with the suspension rod socket.

- B. Pipe racks for a group of parallel conduits shall be galvanized structural steel preformed channels of length as required, suspended on threaded rods and secured thereto with nuts above and below the cross bar. All offsets shall be in the same plane and shall be parallel.

- C. Factory made pipe straps shall be one-hole malleable iron or two-hole galvanized clamps.

- D. Manufacturer: Kindorf, Unistrut, T&B, Copper B-Line or approved equivalent.

2.3 HANGERS AND CABLE TIES

A. Materials:

1. All hangers and cable ties shall be designed to support communications cable (including the fiber) without kinking or damage. Horizontal cable supporting hardware shall be UL Listed. The J-hook(s) shall provide a broad base for proper cable support, thereby reducing stress and bending of cabling. Contractor shall utilize the sufficient number of J-hooks per manufacturer's recommended cable capacities for the number of cables to be installed. One spare j-hook shall be installed at each location for future placement of cables.
2. Hangers shall be metal construction and shall provide a cable support hanger in a "J" configuration designed to support multiple communications cables.
3. No more than twelve (12) station cables may be supported by a single hanger without using a saddle (3 inches wide at a minimum) to support the weight of the additional cables.
4. Larger types of wire hangers (larger J-hooks or Tri-hooks) are acceptable for locations requiring more than twelve cables. Copper and fiber cables must be properly installed per the manufacturer's specifications to insure maximum cable performance.
5. Velcro type cable ties used within a rated ceiling plenum space shall be rated low smoke and shall be certified for use in a plenum environment. (UL Listed) NEC section 300-21.

B. Manufacturers: Hangers: CPI Chatsworth, B-Line, Caddy, or approved equivalent.

Ties: Velcro, T&B, and HellermanTyton or approved equivalent.

2.4 SURFACE RACEWAYS

A. Materials

1. The Contractor shall provide and install surface mounted raceways only in locations where structures cannot be fished. The Contractor must make every effort to conceal station cable within the existing wall structures. Surface mounted raceways are not to be used to "simplify" the installation. The Contractor must obtain approval from the Inspector of Record prior to installation of any surface mounted raceway.
2. The raceway shall be non-metallic with a minimum opening of 1.51 " wide by .94 " high if limited to serving only a single station with no more than 8, category 6, copper cables. Hubbel Premise Trak line of Surface Raceways.
3. If more than ten cables category 6, copper cables and less than 30 cables are being served to multiple data outlets, the raceway shall be non-metallic with a minimum opening of 4.07 " wide x 1.77 " high. Pan-way T-70 Surface Raceway or equivalent. Hubbel Premise Trak line of Surface Raceways.
4. The raceway shall be equipped with all accessories such as elbows, tees, junction boxes, and covers necessary to provide a complete and high quality installation.
5. The raceway material shall meet or exceed UL-5A standards and shall be equipped with a single piece cover or a snap-in-place cover designed to fasten securely.
6. The raceway must be attached to the walls with mechanical fasteners every four feet in addition to any mastic provided as part of the product.

- B. Manufacturer: Hubbel Premise Trak line of Surface Raceways.

2.5 FIBER TERMINAL UNITS

A. Materials

1. The fiber optic terminals/patch panels shall utilize Hubbel OptiChannal® rack mounted enclosures
2. Each enclosure shall have the following specifications:
 - a. Suitable for installation in EIA 19" mounting frame.
 - b. Provide cross-connect, inter-connect, and splicing capabilities and contain the proper troughs for supporting and routing the fiber cables/jumpers.
 - c. Consist of a modular enclosure with retainer rings in the slack storage section to limit the bending radius of fibers.
 - d. Equipped with a "window" section to insert connector panels for mounting of connectorized fibers (LC, duplex, style couplers and connectors).
 - e. Provide terminating capability of couplers, in the quantity noted on the contract drawings, in panels of 6 or 12 respectively.
 - f. Hubbel 2CLICK® LC connectors for 50 µm multimode fiber with ceramic ferrule. The connectors shall have composite couplers in all patch bays that meet or exceed the following specifications:

(1) Hubbel 2CLICK® LC Connectors (multimode 50uM)

(2) Operating Temperature: ≤ 0.3db change -40°C to+70°C

(3) Insertion Loss: 0.3 dB

Multimode 0.1dB average, 0.5 dB max, Return loss: 20dB max.

(4) Durability < or = .2 dB change, 500 remateings

(5) Reflectance: ≤ -50dB (+18° to +-26°C)

(6) Nominal fiber OD: 125 uM

(7) Housing: Engineered polymer housing with Zirconia ferrule

(8) Boot Color: Multimode=Aqua

- B. Manufacturer: Hubbel 2CLICK® (University Standard)

2.6 LABELS

A. Materials:

1. Provide labels for innerduct, connectors, cables, outlets, termination frames and patch panels.

2. The lettering on each label shall be as large as is practicable. All labels shall be machine-produced. Hand-written labels will not be acceptable.
 3. A standard relative orientation shall be adopted for all labels unless otherwise specified.
 4. Labels shall be durable, resist abrasion and shall be UV inhibiting, permanent and indelible.
 5. All labels shall be readily visible and shall be fixed so that they remain in a visible position wherever practical.
 6. Cable labels
 - a. Provide self-laminating wrap labels for cables with less than ½" diameter. The labels shall be permanently attached to each cable once they have been installed.
 - b. Provide laminated, cable-tied labels for innerduct and cables with ½" diameter and greater. The labels shall permanently attach to each cable once they have been installed.
 7. Outlet labels shall be according the University standard. Prior to installing the labels, the Contractor must submit a sample label to the University for approval prior to labeling the new outlets.
- B. Manufacturer: Panduit, or approved equal.

2.7 STATION OUTLETS

A. Materials:

1. Metal Outlet Boxes
 - a. Metal outlet boxes shall be installed as receptacles for the information outlets in the following locations: new interior wall construction, exterior locations, locations with special vapor proof or explosion proof applications, and floor mounted outlets. Outlet boxes shall be galvanized steel. Boxes installed in any exterior location where exposed to rain or moisture laden atmosphere shall be cast screw hub type with gaskets and weatherproof covers. Boxes for vapor proof or explosion proof applications shall be designed specifically for such use.
 - b. In new wall construction, each box shall be flush mounted, **two gang**, metal box. If the outlet is designated for four or less cables, provide a single gang mud ring. If the outlet is designated for more than four cables and less than nine cables, provide a two gang mud ring. Each box shall be equipped with a 1 ¼" conduit stubbed into the ceiling area and equipped with a 12 inch radial bend angled toward cable tray or wire pathway. If cable trays are used as horizontal raceways, the 1 ¼" conduit will be extended to the top of the cable tray.
 - c. Manufacturers: Appleton, Raco, Steel City or approved equal.
2. Non-Metallic Outlet Boxes
 - a. Non-metallic outlet boxes shall be used for interior surface mounted locations only when outlets can be installed inside the wall. Surface mounted outlet boxes must be approved by the University representative prior to installation. Boxes shall be from same manufacturer as the non-metallic raceways used for installation of station wire.

- b. The type of box must be from the same manufacturer and compatible with the Hubbel Premise Trak raceway. Single (one) gang box shall be used in locations with four or less voice and data cables. Dual (two) gang box shall be used in locations with more than four and less than nine cables.
 - c. Manufacturer: Hubbel Premise Trak.
3. Mounting Brackets
- a. For new outlets in existing fishable walls, flush mount brackets shall be utilized in lieu of outlet boxes to attach faceplates.
 - b. Single gang, mounting brackets and faceplates shall be used for outlets with four cables or less. A dual gang mounting bracket shall be used for a new outlet with more than four and less than nine cables.
 - c. Manufacturer: Caddy or approved equal.
4. Standard Data Outlet
- a. The standard data outlet will be used for all data applications as well as voice services.
 - b. The standard data outlet shall consist of three (3) Category 6 four-pair cables, each terminated on a separate Category 6 rated RJ45 8-position jack following T-568 B wiring standards. The color of one jack will be white for voice services and the color of the other two jacks will be blue for data services.
 - c. One of the Category 6 copper cables will be white in color and terminated on the white jack mounted in the outlet. The other end of the cable will be terminated in the telecom room on a 110-A1 100 PAIR comm. block designated for the termination of all white cables.
 - d. Two of the Category 6 copper cables will be blue in color and terminated on the blue jacks mounted in the outlet. The other end of the cables will be terminated in the telecom room on a rack mounted data jack patch panel designated for the termination of all blue cables.
 - f. The modular jacks shall be rated for Category 6 performance in the configuration installed.
 - g. The faceplate will be clearly labeled with outlet number, and each jack will be labeled with jack number. All labels will be typed or preprinted and shall be securely affixed to the faceplate.
 - h. Dust covers shall be placed in the vacant slots and the color of the dust covers the same as the faceplates.
 - i. Manufacturer: HUBBEL Premise Wiring System
5. Other Data Outlets
- a. Other data outlets shall consist of one to eight RJ45 8-wire modular jacks wired as per EIA/TIA 568B in a white outlet faceplate. The number of terminated cables at each outlet shall be according to floor plan drawings. Jacks shall be blue in color.

- b. Data outlets with one to four cables shall have 4 port angled faceplates and data outlets with five to eight cables shall have 8 port angled faceplates.
 - c. The modular jacks shall be rated for Category 6 performance in the configuration installed.
 - d. The faceplate will be clearly labeled with outlet number, and each jack will be labeled with jack number. All labels will be typed or preprinted and shall be securely affixed to the faceplate.
 - e. Dust covers shall be placed in the vacant slots and the color of the dust covers the same as the faceplates.
 - f. Manufacturer: HUBBEL Premise Wiring System (University Standard)
6. Data/Fiber Outlets
- a. The standard data/fiber outlet shall consist of two (2) Category 6 four-pair cables, each terminated on a separate Category 6 rated RJ45 8-position jack following T-568 B wiring standards. The color of the jacks will be blue. The outlet shall also contain (1), two optic, multimode fiber cable. Both ends of the fiber station cable shall be terminated on Hubbel 2CLICK, duplex, LC type connectors suitable for existing type multimode fiber cable.
 - b. The modular jacks shall be rated for Category 6 performance in the configuration installed.
 - c. The faceplate will be clearly labeled with outlet number, and each jack and connector will be labeled per University numbering scheme. All labels will be typed or preprinted and shall be securely affixed to the faceplate.
 - d. Dust covers shall be placed in the vacant slots and the color of the dust covers the same as the faceplates.
 - e. The Category 6 copper cables will be blue in color and terminated on the blue jacks mounted in the outlet. The other end of the cables will be terminated in the telecom room on a rack mounted ADC data jack patch panel designated for the termination of all blue cables.
 - f. Fiber cables to the outlets shall be terminated in the telecommunications room in a fiber terminal unit
 - g. Manufacturer: Category 6 Copper Cables, Hubbel premise NEXTSPEED® cat 6 cable. Fiber Cable, Hubbel Premise® Cable
7. Voice Only Outlets – Wall Phones and Emergency Telephones
- a. b. The voice only outlet designated for wall phone or emergency telephone shall consist of one (1) Category 6 four-pair cable terminated on a Category 6 rated RJ45 8-position jack following T-568 B wiring standards.
 - c. The Category 6 modular jack shall be mounted in a metal faceplate suitable for securing a wall mounted telephone.

- d. Wall phone outlets shall be placed at 44 inches above the finished floor unless otherwise noted to make the maximum height to the top of the telephone 48 inches above the finished floor.
 - e. Wall phone outlets shall be equipped with a duplex mud-ring around the standard dual gang outlet box recessed in the wall. Wall outlets not recessed into wall shall have an appropriate wall bracket to allow installation of Wall Phone Instrument.
 - f. The Category 6, copper cable shall be white in color and terminated on the white jack mounted in the faceplate. The other end of the cable will be terminated in the telecom room on a rack mounted ADC data jack patch panel designated for the termination of all white cables.
 - h. Manufacturer: HUBBEL Premise Wiring System (University Standard)
8. Voice Only Outlets – Pay Phones, Elevator Phones, and Security Cabinets
- a. Voice circuits for pay phones, elevator phones, and security cabinets will be provided over a separate copper cable network for non-switched voice services.
 - b. Each voice outlet shall be wired with one Category 6 cable terminated on a RJ45 wire modular jack assembly. Some voice cables may be hardwired instead of an outlet depending on the equipment manufacturer's requirements.
 - c. Wall phone outlets shall be equipped with a duplex mud-ring around the standard dual gang outlet box recessed in the wall. Wall outlets not recessed into wall shall have an appropriate wall bracket to allow installation of Wall Phone Instrument.
 - d. The Category 6, copper cable shall be white in color and terminated on the white jack mounted in the faceplate. The other end of the cable will be terminated in the telecom room on wall mounted 110A1-100 pair block.
 - e. Manufacturer: HUBBEL Premise Wiring System (University Standard)

2.8 FACEPLATES

A. Materials

- 1. Provide HUBBEL Premise Wiring® flush, wall-mounted faceplate to house work area jacks. The faceplate shall fit over a standard NEMA electrical box fitted with a plaster ring cover and shall be office white in color.
- 2. Provide blanking inserts in all unused faceplate ports. The blanking inserts shall be the same color as the faceplates.

B. Manufacturer: HUBBEL Premise Wiring®

2.9 COPPER CABLE TERMINATION BLOCKS

A. Materials

1. Terminate Category 6, station cables designated for non-switched voice services (Non-VOIP) on 110-A1-100 pair termination blocks. Termination blocks shall be wall mounted adjacent to copper entrance cable, protected terminal with wire management system between terminals.

Manufacturer: HUBBEL Premise Wiring® (University Standard)

2.10 DATA NETWORK PATCH PANELS

A. Materials

1. Data jack patch panels shall be rated Category 6 and covered under the HUBBEL Premise Wiring® structured cabling system extended warranty.
 - a. 19 inch rack mounting as noted on drawings.
 - b. Wired to T 568 B wiring scheme.
 - c. UL certified.
 - d. Equipped with wire retention clips as specified in the in the HUBBEL Premise Wiring® cabling program.
 - f. A 48 port patch panel shall be for terminating blue data cables as specified. The size of this patch panel shall be 48 port to accommodate the blue data cables. Manufacturer: HUBBEL Premise Wiring® (University Standard)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. All installation work shall be performed according to published industry guidelines, rules, and regulations. All Structured Cabling System products shall be installed according to manufacturer procedures.
- B. All pathways shall avoid electromagnetic interference (EMI). Cable that is distributed in partially-enclosed metallic pathways shall be routed with the following minimum clearances:
 1. Four (4) feet from motors or transformers.
 2. One (1) foot from conduit and cables used for electrical power and distribution.
 3. Six (6) inches from fluorescent lighting.
- C. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables and conduit.

3.2 CONDUIT

- A. All conduit shall be routed parallel and perpendicular to walls.
- B. All conduit shall be installed in accordance with NEMA "Standard of Installation" and shall meet applicable local and national building and electrical codes or regulations.

- C. New Conduit runs shall not exceed 100 feet or have more than two 90 degree bends without utilizing appropriately sized pull boxes. No change in direction shall occur in pull boxes. All conduits are to enter and exit pull boxes in the end (short) walls.
- D. No communications outlet boxes shall be "daisy-chained." Each communications outlet shall be served by a separate 1¼ inch (minimum) conduit.
- E. In rooms with a drop or false ceiling, communications outlets shall be served by a one and one-fourth (1¼) inch conduit equipped with a 90 degree sweep stubbed six inches above the false ceiling, angled toward the cable tray or open access area, and shall be equipped with a compression fitting and plastic bushing. All stubs shall be marked "Comm."
- F. All conduits shall be equipped with an approved water or barrier seal in building access points.
- G. All conduits leaving the entrance room for other portions of the building will be fire-stopped after the installation of cable.
- H. All conduits are to be concealed unless installed in exposed ceiling areas as indicated on the drawings. No conduits shall be left exposed in public areas.

3.3 HANGERS AND CABLE TIES

- A. In suspended ceiling and raised floor areas where walker duct, cable trays, or conduit are not available, station wiring shall be bundled with elcro type ties at 5 foot intervals or less.
- B. Tie wraps shall not be over tightened to the point of deforming or crimping the cable sheath.
- C. Hangers supporting the cable bundling shall be attached to the existing building structure and framework.
- D. Hangers must be installed to provide at least 6 inches of clear vertical space between the cable bundling and the ceiling tiles.
- E. Hangers shall be spaced at 5-foot intervals to prevent cables from sagging or buckling.

3.4 RACEWAYS

- A. All surface-mount raceways must be mechanically secured to the structure a minimum of every four feet.
- B. Raceways must be routed at right angles to nearby structures or wall corners, and shall be neatly installed and trimmed to fit into and around other existing moldings or pathways such as the ceiling area.
- C. Raceways shall be placed vertically only in corners of rooms and horizontal raceway placed at baseboard height to extend the cable run to the actual outlet location.
- D. Raceways shall be routed to avoid interference, using standard sections and a minimum number of field-cut sections.
- E. Raceways shall be routed to avoid interference with removal and installation of lighting fixtures and devices of other systems that require servicing or operation.
- F. Sharp burrs or edges shall be removed from raceways.

- G. Completed raceways shall have no cracks or openings at coupled sections.
- H. Raceway supports:
 - 1. Overhead Supports: Raceway shall be supported from concrete ceiling or ceiling beams, at five (5) feet maximum span intervals, using 3/8 inch threaded rods with c-hangers.
- I. Strict adherence to the CEC/NEC NFPA 101 is required for any raceway penetrations of fire-rated walls. See section 07840 for UL system numbers and to construction drawings for details.
- J. Radius fittings shall be provided for turns and offsets to accommodate obstructions or elevation changes and maintain minimum cable bending radii.

3.5 FIBER OPTIC TERMINAL PANELS

- A. Rack-mounted fiber panels shall be mounted at the top of the rack.
- B. All cables mounted into fiber optic panels shall be installed and secured as defined by the manufacturer using the tools, materials, and techniques outlined by HUBBEL Premise Wiring.
- C. All optics shall be terminated in accordance with HUBBEL Premise Wiring® specifications using 2CLICK, duplex, LC type connectors.

3.6 CABLE TAGS AND LABELING

- A. The Contractor shall legibly label all voice and data outlets, cable, blocks, frames, and patch panels per construction drawings and owner's representative directions and as defined herein. Outlet faceplates shall be labeled on both sides.
- B. The Contractor shall employ the cable labeling and tagging scheme that meets ANSI-606 specifications and as specified on construction drawings by the engineer.
- C. Construction labels shall be installed on all cables as they are pulled. These labels shall contain the same information as the finished labels. Each station cable shall have a unique number that shall be related to the appropriate faceplate number and jack letter. Typed labels on self-sealing tape shall be used.
- D. A label shall be installed on each conduit attached to a communications wall box and shall be affixed to the end of the conduit near the cable tray. The label shall have a unique number related to the appropriate faceplate number and jack letter.
- E. Labels shall be installed on all station cables within two (2) inches of the end of the outer jacket material within the back box and at the blocks/patch panel. Typed labels on self-sealing tape, with a plastic overlay, shall be used. Each cable shall have a unique number that shall be related to the appropriate faceplate number and jack letter.
- F. Labels shall be installed on all patch panels, blocks, and both the inside and outside of all faceplates. A uniquely numbered label for each faceplate and a unique letter for each jack shall be supplied and installed. The labels shall be machine printed (not embossed) on vinyl tape using a Brothers label maker or equivalent. The labels shall have protective overlays.
- G. Labels shall be numbered according to the drawings.
- H. Ground Bars

1. The master ground bar shall be labeled as such.
2. Each subsidiary ground bar shall be labeled as such and have a unique identifier.
3. All ground bars shall have a warning label that states, "If this connector or cable is loose or shall be removed, please call the ACIT Manager.
4. Each ground cable shall be labeled with a unique identifier.

3.7 STATION OUTLETS

- A. Station outlets shall be located so that the cable from the outlet to the telecom room is less than 90 meters (295 feet). Immediately notify the owner's representative if the cable can not be installed within the distance limitations due to field conditions.
- B. Station outlets shall be mounted securely at work area locations.
- C. Station outlets shall be located so that the cable required to reach the desktop equipment is no more than 16 feet long.
- D. Station outlets shall not be "daisy-chained."
- E. Outlets shall be mounted as follows:
 1. Wall phone: 44 inches above the finished floor.
 2. Standard data outlet: 15 inches above the finished floor unless otherwise noted on drawings. Coordinate height of telecom outlets to match height of electrical outlets.
 3. Wall-mounted video outlet: 15 inches above the finished floor unless otherwise noted on drawings. Coordinate height of telecom outlets to match height of electrical outlets.
 4. Counter top: 6 inches above the counter top.
- F. Modular Furniture Telecommunications Outlets
 1. The Contractor shall provide and install all components and labor necessary to completely install, test, and document voice and data telecommunications outlets at each modular furniture workstation location.
 2. The Contractor shall coordinate the telecommunications and electrical installation so that the modular furniture is served from the joint signal/power floor boxes or joint power pole in a consistent manner. The Contractor shall provide and install all fittings, flex conduit, adapter plates, and telecommunications cable and components necessary to install Category 6 station cable from the telecommunications room through the ceiling, floor box, or pole, into the furniture raceway, and to the final user outlet location (including jacks, adapters, and faceplates).
- G. Labels shall be numbered according to a scheme developed in consultation with the owner's representative.

3.8 FACEPLATES

- A. The faceplates shall have their jack positions labeled.

3.9 COPPER CABLE TERMINATION BLOCKS

- A. All voice terminal blocks shall be clearly and neatly labeled with outlet (jack) or pair assignments.
- B. All outlets shall be numbered sequentially in the telecom room using a numbering assignment as shown on the drawings.
- C. All riser, tie, and data terminals shall be numbered using pre-printed identification strips. The engineer of record shall determine numbering methodology unless otherwise noted.
- D. All terminal locations shall be approved prior to installation.
- E. All work on terminals shall be accomplished using tools and support hardware designed for the HUBBEL Premise Wiring systems and following procedures identified by the manufacturers.

3.10 EQUIPMENT RACKS

- A. The telecommunications rooms will be equipped with equipment racks as noted on construction drawings. Wherever possible, allow a 36" wide aisle way in the front and in the rear of each equipment rack.

3.11 PULL BOXES AND CABINETS

- A. Pull boxes shall be installed in easily accessible locations.
- B. Pull boxes installed as part of a horizontal cabling pathway shall be installed at minimum six (6) inches immediately above suspended ceilings, where possible.
- C. Pull boxes shall not be used for splicing cable.
- D. Pull boxes shall be placed in conduit runs that exceed 100 feet or which require more than two 90-degree bends. The pull boxes shall be located in straight sections of conduit and must not be used for a right angle bend. Installation shall allow cable to pass through from one conduit to another in a direct line.
- E. Pull boxes must have a length of at least 12 times the diameter of the largest conduit.
- F. Surface-Mounted Entrance Cabinets: Those mounted on an outside wall to serve a smaller building shall be at least 36" x 24" x 6" deep. Cabinets must provide full access from the front and access to an approved ground. Cabinets shall be equipped with a ¾ inch backboard.

3.12 WIRE MANAGERS

- A. Both vertical and horizontal wire managers shall be placed on each equipment rack in the telecommunications room as shown on construction drawings details. Wire managers are to provide a clear and unobstructed pathway to route jumper wires.

3.13 DATA NETWORK PATCH PANELS

- A. All data station cables shall be terminated on 48 port, category 6, rack mounted jack patch panel. All data station cables shall be terminated to T 568 B wire scheme. Data station cables are to be routed from the entry point in telecommunications room along the ladder racking in a neat and orderly way, bundled together and protected from damage or distortion.

END OF SECTION

SECTION 270725 TELECOMMUNICATIONS CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Copper Station Cable
- B. Fiber Station Cable

1.2 RELATED SECTIONS

- A. Section 270710 – Telecommunications General Requirements
- B. Section 270715 – Acceptance Testing
- C. Section 270720 – Basic Materials and Methods
- D. Section 270760 – Telecommunications Grounding and Bonding

1.3 APPLICABLE PUBLICATIONS

- A. As defined in Section 270710 – Telecommunications General Requirements.

1.4 SUBMITTALS

The Contractor shall submit the following materials to the owner's representative prior to the placement of cable:

- A. Product data, including both product construction and performance specifications, for each type and configuration of cable to be supplied. Proof of Structured Cabling System certification.
- B. Copies of signed optical cable reel tests.

PART 2 - MATERIALS

2.1 COPPER STATION CABLE (CATEGORY 6, PLENUM)

- A. Material
 - 1. Application: Use for voice and data applications to interconnect services from workstation to the wiring closet in a plenum or non-plenum rated space.
 - 2. Compliance: UL 444, UL 910, UL 1666 ISO/IEC 11801-1995, ANSI/TIA/EIA 568-B.2, NEC Listed MPP/CMP, Verified to category 6 as defined by EIA/TIA standards intended for use with transmission rates up to and including gigabit Ethernet.
 - 3. Make up: Four unshielded twisted pair, solid annealed bare copper conductors insulated with FEP and covered with a flame retardant PVC jacket.
 - 4. All copper station cable shall be Category 6, Plenum rated.

5. Station cables shall have a color jacket as follows:
 - a. White - Voice
 - b. Blue - Data
- B. Manufacturer: Hubbel premise NEXTSPEED® Category 6 Cable

2.2 FIBER OPTIC STATION CABLE

A. Materials

1. Application: Intrabuilding backbone and horizontal installations in plenum environments.
2. Compliance: Meet or exceed NEC® OFNP; CSA FT-6
3. General Characteristics:
 - a. Flame retardant jacket
 - b. All-dielectric construction
 - c. 900 µm TBII® buffered fibers
 - d. Standard fiber cable from information outlet to telecommunications room. Either singlemode, multimode, or hybrid cable as noted on drawings.
 - e. Gigabit Ethernet and 10 Gigabit Ethernet performance
4. Singlemode Characteristics:
 - a. 9 µm core and /125 µm cladding.
 - b. Windows 1310 nm, 1383 nm, and 1550 nm.
 - c. Maximum attenuation:
1.0 dB/km @ 1310 nm
1.0 dB/km @ 1383 nm
.75 dB/km @ 1550 nm.
 - d. Serial 10 Gigabit Ethernet Distance: 10,000/40,000
 - e. .275 numerical aperture
 - f. Minimum pulling tension of 600 lbs.
 - g. Equipped with a breakout, furcation, or blocking kit to dress the end of the cable and eliminate the flow of fill compound
5. Multimode Characteristics:
 - a. 62.5/125 µm (core/cladding) dual window (850 and 1300 nanometers)

- b. Maximum attenuation: 3.0 dB/km @ 850 nm and 1.5 dB/km @ 1300 nm
 - c. Minimum LED Bandwidth: 1500 MHz/km @ 850 and 500 MHz/km @ 1300 nm
 - d. e. . 275 numerical aperture
 - f. Minimum pulling tension of 600 lbs.
 - g. Equipped with a breakout, furcation, or blocking kit to dress the end of the cable and eliminate the flow of fill compound
- B. Manufacturer: Hubbel premise NEXTSPEED® Plenum Cable

2.3 COPPER STATION CABLE (CATEGORY 6, OUTDOOR CABLE)

A. Material

1. Application: Use for voice and data applications for cables placed in underground outside plant conduit.
2. Compliance: ETL Verified TIA/EIA-568-B.2-1 Category 6 Horizontal ISO/IEC 11801 Category 6 Horizontal Cable Requirements. Verified to category 6 as defined by EIA/TIA standards intended for use with transmission rates up to and including gigabit Ethernet.
3. Make up: 24 AWG solid bare copper conductors, thermoplastic insulation, flexweb core separator filler, moisture barrier core wrap core tape, linear low density polyethylene, black 0.271" nominal O.D. jacket.
4. Category 6, 4-pair, outdoor rated cable.

- B. Manufacturer: Mohawk M57622

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. All installation work shall be performed according to published industry guidelines, rules, and regulations. If disputes occur, local, state, and national codes have precedence; then University policies and procedures; then standards such as EIA/TIA; then guidelines from firms such as Building Industry Consulting Services International (BICSI), SBC, Verizon, then finally, manufacturer recommendations.
- B. The Contractor shall provide sufficient trained staff to monitor all work undertaken and ensure that the requirements of these specifications are met throughout the installation process.
- C. All tests will be conducted using equipment that has Laboratory or manufacturer certified calibration within six months of the tests. The Contractor shall provide a signed copy of the calibration test results for each item of test equipment with the acceptance documentation.
- D. All installation work will be of the highest quality. The Contractor shall at all times make every effort to conduct all installation work in a manner so as to minimize the impact on the facilities. Whenever possible, all work will be hidden behind finished materials and all surfaces will be returned to their original condition.

- E. The Contractor shall provide and install all pathway and cable support hardware necessary to successfully complete the installation. This includes, but is not limited to, hangers, ladder racks, support brackets, conduit and sleeves, firestop materials, tie-wraps, and access openings such as core drills.
- F. The Contractor shall ensure that only staff fully qualified to work on specific types of materials are allowed to undertake the required installation. Particularly, copper and fiber optic cable placement, termination, splicing, and testing shall only be undertaken by staff who are certified by the selected Structured Cabling System manufacturer.
- G. The Contractor shall provide all hardware, software, and miscellaneous components necessary to provide a complete system.
- H. The Contractor and the owner's representative shall inspect cable for cuts and abrasions that penetrate the outer sheath of the cable to see if it must be replaced or patched. The work will be scheduled so that the voice and data networks will be out of service for a minimum period of time.

3.2 COPPER STATION CABLE

- A. All copper station cables shall be neatly dressed, secured, and concealed throughout the installation. Copper station cables shall be secured with Velcro straps, but shall not deform the cable geometry. The Velcro straps shall be of a plenum-rated material if copper station cable is installed within a plenum ceiling space.
- B. No copper station cables shall be exposed in any rooms with open ceilings. A minimum of one 1 ¼" conduit shall be extended to the cable tray or telecom room.
- C. All copper station cables shall be secured a minimum of six (6) inches above the ceiling T-bar grid. Ceiling grid supports, electrical conduit, water pipes, and HVAC ducting may not be used to support cables. In those areas without adequate support structures, the Contractor shall install "J" hooks or additional ceiling grid hangers on five foot centers. Copper station cables shall not be placed within 24 inches of overhead lights or any other potential source of electrical interference.
- D. In any area in which a fire-rated wall, partition, floor, or ceiling is penetrated, the Contractor shall be responsible for creating the pathway and sealing around all copper station cables and sleeves with a UL classified fire seal sufficient to return the structure to its original rating. Creation of such openings as are necessary for copper station cable passage between locations as shown on the drawings shall be the responsibility of the Contractor. Any opening in a rated structure created by the Contractor that is larger than one inch in diameter shall be equipped with a metal sleeve secured and fire-stopped in place.
- E. In station locations with walls that must be fished, the Contractor shall place a plaster wall retaining ring or metal supporting "ears" around the outlet location to secure the outlet and faceplate. No exposed copper station cable shall be permitted.
- F. In locations where the wall will not be fished and surface-mount raceways are utilized, all raceways must be mechanically secured to the structure a minimum of every four feet, must be routed at right angles to nearby structures or wall corners, and shall be neatly installed and trimmed to fit into and around other existing moldings or pathways such as the ceiling area. Raceways shall be placed vertically only in corners of rooms and horizontal raceway placed at baseboard height to extend the cable run to the actual outlet location.

- G. All copper station cables shall have ten (10) feet of cable slack stored in the BDF/IDF and twelve (12) inches stored above the outlet. Do not store any copper station cable slack in bundled loops. Store copper station cable slack in an extended loop or in a figure 8 configuration to alleviate stress.
- H. The Contractor is responsible for removing, replacing, and repairing ceiling tiles in order to route all cables. Concealed spline ceiling tiles shall not be replaced until installation work in that area has been inspected and reviewed with University representative and the Engineer of Record and approval given to re-fix the ceiling in place.
- I. The voice network copper station cables shall be terminated on Category 6 rated patch panels or wall mounted terminal blocks as specified under Station Outlets in spec section 16720.
- J. The data network copper station cables shall be terminated on Category 6 rated patch panels.
- K. All copper station cables shall be clearly identified at both ends with a cable numbering system per TIA/EIA 606-A. All labels will be securely attached to each end of the copper station cable whenever it enters or leaves a conduit. The copper station cables shall also be labeled at thirty (30) foot intervals when run in accessible areas such as tunnels, manholes, ceilings, etc. All labels shall identify the cable type, size, and counts, as noted on the drawings.
- L. The minimum bending radius of the copper station cables must not be exceeded during cable placement, per manufacturer specifications.

3.3 LABELING REQUIREMENTS

- A. All copper and fiber optic cables shall be labeled per the requirements identified in spec section 16720.

END OF SECTION

**SECTION 270760
TELECOMMUNICATIONS GROUNDING AND BONDING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Related Sections
- B. Applicable Publications
- C. Work Sequencing and Coordination
- D. Telecommunications Submittals
- E. Quality Assurance
- F. Project Record Documents
- G. Qualifications
- H. Regulatory Requirements
- I. Performance Requirements
- J. Materials
- K. Execution

1.2 RELATED SECTIONS

- A. Section 270710 - Telecommunications General Requirements
- B. Section 270715 - Telecommunications Acceptance Testing
- C. Section 270720 - Telecommunications Basic Materials and Methods
- D. Section 270725 - Telecommunications Cable.

1.3 APPLICABLE PUBLICATIONS

- A. American National Standards Institute (ANSI) Publication: C2-93 National Electrical Safety Code
- B. Electronic Industries Alliance and Telecommunication Industries Association (EIA/TIA) Publications:
 - 1. EIA/TIA 568 B - Commercial Building Telecommunications Wiring Standard 2001
 - 2. EIA/TIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces 1998
 - 3. EIA/TIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications 1994

- C. Institute of Electrical and Electronic Engineers (IEEE) Publication: 142-1991 Recommended Practice for Grounding of Industrial and Commercial Power Systems
- D. 2001 California Electrical Code (CEC)
- E. Underwriters Laboratories, Inc. (U.L.) Publication:
 - 1. 83-1983 Thermoplastic Insulated Wires
 - 2. 467-84 (R86) Grounding and Bonding

1.4 WORK SEQUENCING AND COORDINATION

- A. The Contractor shall coordinate interconnection to the University's existing grounding and bonding system with the Project Manager/Inspector of Record. All connections to the existing buildings systems should be performed without affecting the existing building grounding system. However, if any out of service activity is required, the work shall be coordinated a minimum of fourteen (14) days in advance with the Project Manager/Inspector of Record.

1.5 SUBMITTALS

The Engineer of Record shall receive the following Contractor submittals:

- A. Product data for:
 - 1. Conductors
 - 2. Connections (all types)
 - 3. Ground Connectors (Crimp Type)
- B. Manufacturer's Instructions: include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

1.6 QUALITY ASSURANCE

- A. All grounding and bonding system work shall be tested and documented as defined in Section 16715 - Telecommunications Acceptance Testing.
- B. For products or workmanship specified by association, trade, Federal, or State Standards, the Contractor shall comply with the requirements of the standard, except when more rigid requirements required by applicable codes or University standards shall apply.
- C. The Contractor shall conform to reference standard by date of issue current on final design documents.

1.7 PROJECT RECORD DOCUMENTS

- A. The Contractor shall accurately record and submit to the Engineer of Record complete data regarding signal ground wire pathways, points of bonding, and point of connection to building grounds.

1.8 REGULATORY REQUIREMENTS

- A. Telecommunications grounding and bonding shall conform to requirements of CEC, NEC, and ANSI C2.

1.9 PERFORMANCE REQUIREMENTS

- A. Point-to-Point Resistance: 0.5 ohms or less.

PART 2 - MATERIALS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall conform to the respective standards and to the specifications stated herein. Electrical ratings shall be as indicated. Except where specifically indicated otherwise, the Contractor shall provide only new materials having all legally required approvals and/or labels. Materials shall conform to the requirements of UL 467 where applicable.

2.2 CONDUCTOR, UL 83

- A. Ground and bonding conductors shall be green-insulated, soft-drawn stranded copper conductors, unless otherwise indicated, installed with sufficient slack to avoid breaking due to settlement and movement of conductors or attached points.
- B. System grounding conductors shall be minimum of 3 Ø AWG bare copper, unless otherwise indicated, and shall be continuous with no joints or splices and placed in a 1" conduit.

2.3 CONNECTORS AND TERMINALS

- A. Wire Connectors and Terminals for use with Copper Conductors shall conform to UL 486-A.

2.4 GROUND BUS BARS

- A. Provide ground bar with tapped standard NEMA bolt holes for 2-hole compression connectors, mounting brackets and insulators, sizes as indicated:
 1. 1/4" x 4" x 12", Lyncole XIT or approved equal in the BDF.
 2. 1/4" x 4" x 5.25", Lyncole XIT or approved equal in all other telecommunication spaces.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall provide grounding and bonding in accordance with the requirements of NFPA 70, IEEE 142, EIA/TIA 568, EIA/TIA 607, state and local codes, the University standards and to

requirements specified herein. Codes shall be complied with as a minimum requirement, with these specifications prevailing when they are more stringent.

3.2 BONDING

- A. Metallic conduits, wireways, metal enclosures of busways, cable boxes, equipment housings, cable racks and all non-current carrying metallic parts of the installed telecommunications services shall be grounded with #6 AWG copper wire. The metallic conduit system shall be used for equipment and enclosure grounding but not as a system ground conductor.
- B. All metallic conduit stub-ups shall be grounded, and where multiple stub-ups are made within an equipment enclosure, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.
- C. Each metallic raceway, pipe, duct and other metal object entering the buildings shall be bonded together. The Contractor shall use #6 AWG bare copper conductors.
- D. The Contractor shall bond telecommunications equipment and busbars separately.

3.3 SIGNAL REFERENCE GROUNDING AND BONDING

- A. Each identified telecommunications space within a building shall have a common signal reference ground. The signal reference ground shall conform to the following:
 - 1. Within the building, all communication spaces shall be separately bonded to each other and connected to the primary building ground in accordance with the provisions of EIA/TIA 607. The communication ground shall not ground any other equipment or be connected to any potential high voltage source. All racks, frames, drain wires, and all installed communication equipment shall only be grounded to this common reference ground with a minimum size #6 AWG copper wire.
 - 2. The Building Distribution Frame (BDF) shall be equipped with a telecommunications main grounding bus bar (TMGB) of minimum 1/4" x 4" x 12" dimensions mounted on the telecommunications backboard 6 inches above finished floor. This point of single reference shall be grounded with a minimum #3 \varnothing AWG ground conductor in a 1 inch diameter conduit to the main building ground. The building ground for signal reference shall be the building service entrance ground.

3.4 FIELD TESTS

- A. As an exception to requirements that may be stated elsewhere in these documents, the Inspector of Record shall be given five (5) working days notice prior to each test. The Contractor shall provide all test equipment and personnel and shall provide written copies of all test results.
- B. Grounding and bonding system conductors and connections shall be inspected for tightness and proper installation.
- C. The Contractor shall provide personnel and test equipment for point-to-point resistance tests before connecting equipment. Perform point-to-point tests to determine the resistance between the main grounding system and the BDF ground bus bar. Investigate and correct point-to-point resistance values that exceed 0.5 ohm. The Contractor shall record resistance measurements at all test point locations.

END OF SECTION