Palomar College Escondido HVAC Lab

1951 East Valley Parkway, Escondido, CA 92069

5015021-100

Palomar Community College District

1951 East Valley Parkway, Escondido, CA 92069



October 4, 2018

HMC Architects

Palomar College Palomar College Escondido - HVAC Lab

October 4, 2018 HMC # 5015021-100



HMC ARCHITECTS Architect



Saiful Bouquet Structural Engineers Structural Engineer



MA Engineers Mechanical/Plumbing Engineers



IDENTIFICATION STAMP DIV. OF THE STATE ARCHITECT APP. 04-117752 INC: **REVIEWED FOR** ss 🗹 FLS 🗹 👘 STACS 🗹 12/13/2018 DATE:

Johnson Consulting Engineers Electrical Engineer

Palomar College Palomar College Escondido - HVAC Lab

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Snypes-Dye Civil



P2S Communication / Fire Suppression

IDENTIFICATION STAMP DIV. OF THE STATE ARCHITECT		
APP. 04-	117752 INC:	
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DEMOLITION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Remove designated building equipment, fixtures, components and utilities to permit installation of new construction.
- B. Include Work required to demolish and remove elements of existing construction including partitions, ceilings, flooring, walls, concrete, paving and sub base, doors and similar elements of existing building construction, all as noted on Drawings or as required to permit installation of new construction. Refer to Cutting and Patching in Section 01 70 00 for differentiation between "Demolition" and "Cutting and Patching".
- C. Comply with Title 24, Part 9, California Fire Code, Chapter 33 Fire Safety During Construction and Demolition, during all Phases of project.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. CBC 2016 California Building Code
 - 1. CBC-19A CBC Chapter 19A, Concrete (for DSA)
 - 2. CBC-33 CBC Chapter 33, Safeguards During Construction
 - C. CCR California Code of Regulations
 - 1. CCR-8.4 Title 8, Subchapter 4, Construction Safety Orders
 - D. CFC 2016 California Fire Code
 - 1. CFC-5 CFC Chapter 5, Fire Service Features
 - 2. CFC-7, CFC Chapter 7, Fire-Resistance-Rated Construction
 - 3. CFC-9 CFC Chapter 9, Fire Protection Systems
 - 4. CFC-33 CFC Chapter 33, Fire Safety During Construction and Demolition
 - E. ICRI International Concrete Repair Institute.
 - F. DSA IR 25-5 Division of the State Architect Interpretation of Regulations
 - G. NFPA National Fire Protection Association
 1. NFPA 241- Safeguarding Construction, Alteration and Demolition Operations
 - H. SCAQMD South Coast Air Quality Management District
 - 1. SCAQMD-1403 Rule 1403, Asbestos Emissions from Demolition/Renovation Activities

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Demolition Conference: Conduct conference at Project site to comply with below and requirements in Division 01.
- B. Contractor shall schedule meeting after Notice of Award to review demolition operations.
- C. Attendance Required: Owner, Architect, Contractor, Demolition Subcontractors, Project Inspector.
- D. Construction Process:
 - 1. Contractor shall discuss overview of demolition procedures.
 - 2. Contractor shall identify items to be selected by Owner for salvage.
 - 3. Contractor shall review special requirements for equipment, safety, and noise.
- E. Architect will record minutes and distribute copies within seven days after meeting to participants and those affected by decisions made.
- F. Regulatory Requirements: Secure demolition permit from the Local Air Quality Management District for renovations involving the removal of 100 square feet/linear feet or greater of demolition, per District Regulations. Notify the AQMD at least 10 working days prior to commencement of demolition/renovation.
- 1.04 SUBMITTALS
 - A. Project Record Documents accurately record actual locations of capped utilities.
- 1.05 EXISTING CONDITIONS
 - A. Before beginning Work, investigate and verify existence and location of mechanical, drainage, and electrical systems and other construction affecting Work, including underground utilities.
 - 1. Before construction, survey and record points of connection of utility services.
 - 2. Locate invert elevation at points of connection to existing sanitary and storm drain, water-service piping, and underground electrical services.
 - 3. Employ a utility service locator company to locate underground utilities.
 - 4. Verify Owner's Record Drawings.
 - 5. Furnish survey of existing utilities.

PART 2 - PRODUCTS

- 2.01 NOT USED.
- PART 3 EXECUTION
- 3.01 PREPARATION
 - A. Disconnect, remove and cap designated utility services within demolition areas. Notify Owner 48 hours in advance of any utility shut-down.

- B. Prior to commencement of demolition operations, notify Underground Service Alert of Southern California (800) 422-4133, Monday through Friday, 7:00 A.M. to 5:00 P.M.
- C. Protection:
 - 1. Protect existing items that are not indicated to be altered.
 - 2. Adequately protect staff and public from harm and accident during demolition operations by the erection of proper barricades, signs, lighting, guard rails or other safety precautions. Conform to Title 8, Subchapter 4, CCR and NFPA 241.
 - 3. Protective Devices: Install substantial enclosures, weatherproof and dust-proof shields, protective covers, screens and similar devices. Erect and move when necessary to permit use of existing rooms, areas or facilities. Remove entirely when their use is no longer essential. Patch or repair all areas where devices have been removed.
- D. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or video.
 - 1. Comply with requirements specified in Section 01 32 33 "Photographic Documentation."
 - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 - 3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.02 TEMPORARY MEASURES - LIFE SAFETY

- A. Emergency Exits: No enclosure, shield or protective covering shall interfere with use of emergency exits in existing facilities at any time. Rated egress systems shall provide temporary rated egress.
- B. Maintain fully charged certified compliant fire extinguishers and water hoses readily available during demolition operations, per Section 906 CBC. Test electrical conductors for disconnection prior to removing.
- C. Provide temporary, but equivalent, fire alarm, detection or suppression systems when any system is impaired by Work of this Section. Temporary systems shall be inspected and tested monthly or at other more frequent intervals as required by Owner.
 - 1. Impairment of fire protection systems, Section 3308.6: Impairments to any fire protection system shall be in accordance with Section 901.
 - 2. Systems out of Service: Per requirement of Section 901.7 through 901.7.6, California Fire Code.
- D. Maintain free and unobstructed access to emergency services per Title 19, CFC 503.1; 503.1.1, 503.4; and Appendix D, CFC Chapter 33 Sections 3310.1; 3312.1 and when required by Owner.
- E. Post NO SMOKING signs in English and Spanish, in number and location as approved by Architect.

- F. Reduce flammable and combustible fire load to minimum by daily removal of debris.
- G. Instruct construction personnel in fire safety and fire drill policies appropriate for areas where demolition operations occur.
- H. Deployment, disposition, administration and implementation of any and all safety measures shall be sole responsibility of Contractor.

3.03 EXECUTION

- A. Demolish in orderly and careful manner. Maintain protected egress and access at all times.
- B. Except where noted otherwise, immediately remove demolished materials from site and dispose legally. Do not utilize Owner's disposal system.
- C. Remove materials to be re-installed or retained in manner to prevent damage. Store and protect until re-installation.
- D. Do not burn or bury materials on site.
- E. Upon completion of Work, leave areas of Work in clean condition.

3.04 SELECTIVE DEMOLITION, REPAIR AND ALTERATIONS WORK

- A. New and existing Work that is cut into, altered, damaged, relocated or reinstalled shall be restored to original conditions. Workmanship and materials to conform to applicable provisions of other applicable Sections of Specifications.
- B. Cutting Equipment: Jack-hammers and vibratory cutting equipment may be utilized under following conditions:
 - 1. Approval by Owner.
 - 2. Time of day and duration of Work on each given day shall be coordinated with Project Inspector and Owner. Minimum of 24 hours advance notice required.
 - 3. Compressors shall be well muffled.
 - 4. Every consideration shall be exercised toward comfort of staff and public. Excessive noise or vibrations will constitute just cause for immediate stoppage of Work.
- C. Cutting:
 - 1. Conform to Provisions of Division 01, General Requirements.
 - 2. Concrete: Cut with saws or other approved method, but do not overcut openings. Reinforcing bars, except where bonded into new concrete, shall be cut off and ends painted with bituminous paint before being enclosed.
 - 3. Structural Members: Cut only when authorized by Architect and approved by Structural engineer of Record, and DGS/DSA. Agency approvals shall be obtained by Architect, not by Contractor.
 - 4. Slab-on-grade concrete cutting: saw cut areas indicated, remove aggregate course and excavate subgrade for utility trenches required for depths, and for other non-utility areas as indicated.



- a. Bedding materials for utility trenches: sand consisting of natural or manufactured granular material conforming to Subsection 200-1.5.5, SSPWC, must achieve compaction of a minimum 90%.
- b. Backfill, stockpiled fill: Granular, free of debris, no gravel larger than 3 inches in any dimension, non-expansive, approved by the Architect prior to placement on the site. Install clean backfill and re-compact 6" lifts to 90% per ASTM D1557.
- c. Install reinforcing steel, match existing sizes and spacing, minimum #3 deformed bars spaced 18" oc. Dowel in place by drilling 12" inches into existing concrete and epoxy in place.
- d. Underslab Vapor Barrier: ASTM E 1745, Class A, 15 mils thick, Permeance as tested before and after mandatory conditioning (ASTM E 1745 Section 7.1 and sub-paragraphs 7.1.1 7.1.5): less than 0.01 grains/(ft²/hr/inHg).
- e. Install and finish Concrete, minimum 4000 psi compressive strength. Finish: to match existing surface.
- D. Removal of Existing Floor Finishes:
 - 1. Remove existing floor covering materials in areas indicated.
 - 2. Sandblast concrete floor surfaces (or submit alternate method to Architect for approval) to remove remaining adhesive, mortar, paint and similar materials which will affect bond of new floor coverings. International Concrete Repair Institute, ICRI Concrete Surface Profile CSP #3 (light shot blast).
 - 3. Patch voids with non-shrink grout.
 - 4. Grind high spots and fill low spots to provide an even surfaced substrate for specified new floor covering materials. Leveling materials shall be compatible with mortars and adhesives required to install finish floors. Floors shall not vary more than 1/4 inch in 10 feet as determined with straightedge.
- E. Modular Materials
 - 1. Resilient tile (VCT), ceramic tile, quarry tile, or similar materials: Remove to joint line without leaving damaged or defective units where joining new construction. After flooring removal, clean substrates to remove setting materials and adhesives.
 - 2. Wall Removal: Remove tiles, setting materials, bonding or adhesive, metal lath, board materials to joint line or support line on stud. Verify stud to receive new construction.
- F. Patching, Repairing and Finishing:
 - 1. Concrete: Edges of existing concrete shall be kept damp for 24 hours and scrubbed with Neat Portland Cement grout just before new concrete is placed. In lieu thereof, an approved epoxy concrete adhesive may be used. Finish shall match existing adjoining Work.
 - 2. Unless otherwise approved concrete shall match strength of existing concrete or be minimum 3000 psi concrete for patching slabs on grade. Strength of concrete for patching structural members or deck fill shall be determined by Architect. Where cut edges are to remain exposed, finish edges with cement mortar at least 3/4 inch thick, applied over epoxy adhesive and finished to match adjoining surfaces.
 - 3. Concrete mix for patching shall comply with Section 1905A.3 California Building Code

- 4. At Removed Flooring Materials: trowel with patching compound, cement based at all areas, leave level, smooth ready to receive new flooring finish materials. At contractor's option install cement-base self-leveling underlayment at no cost to the Owner.
- 5. At removed casework and equipment: repair and patch surfaces with like materials and to match adjacent surfaces. Leave surfaces in acceptable condition as determined by the Architect to received new finishes.
- G. Asphalt Paving: remove AC paving where indicated in drawings and disposed in legal dumpsites, crushing operations on site and re-use of pulverized AC not permitted.
- H. Removal of concrete flatwork: remove concrete paving (panel) to the nearest expansion joint or contraction joint and provide matching concrete surface to abut to new work at same finish levels unless noted otherwise.
- I. Acoustical Ceilings: Existing acoustical ceiling that will be partially removed or will require patching, shall be repaired (or extended) with materials and suspension system identical to existing materials and suspension system.
- J. Doors: Remove units in manner to minimize damage to framing supports and finishes. Remove or cut associated anchorage to permit new installation. When walls are to remain in place disassemble units carefully to prevent damage to wall.
- K. Painting: Areas to be repainted or patched shall be prepared and finished as specified in Section 09 90 00, Painting. Where painting of existing surfaces is scheduled, paint manufacturer's standard specification for interior or exterior maintenance painting may be utilized, when approved by Architect for each surface application.
- L. Holes required through existing stud wall, concrete or masonry construction to accommodate new electrical conduits and piping and ductwork shall be provided as specified in Division 22, Plumbing; Division 23, Heating Ventilating and Air Conditioning; Division 26, Electrical and Division 27 Communications. Provide proposed routing of utilities as required in Coordinated Drawing, Division 01, General Requirements.
- M. Holes required through concrete or masonry Work required for structural purposes shall be neatly drilled as required to accommodate specific items. Coring shall be performed with approval of Architect and in accordance with details on Drawings.
 - 1. Approval of details by DGS/DSA is required. Agency approvals shall be obtained by Architect, not by Contractor.
- N. Work shall be fully coordinated to ensure proper sequence, limits, methods and time of performance. Arrange Work so as to impose a minimum of hardship on present operation of facilities.
- O. Remove such existing ceilings, floors, walls, finish materials or equipment as required to complete Work. Restore such surfaces to their original condition after Work is completed.
- P. Provide adequate ventilation during all operations to prevent accumulation of dust, fumes, vapors or gases.

- Q. Miscellaneous Removal Items: Items not specifically mentioned shall be removed as indicated on drawings.
- R. Miscellaneous Work: Items not specifically mentioned shall be repaired, patched or finished like new Work or to match existing adjoining surfaces as approved. Surfaces damaged shall be restored to original condition.
- 3.05 SALVAGE AND DISPOSAL
 - A. Salvage: Offer Owner first right of refusal for the following removed materials that may have residual value. Remove items designated by the Owner to be salvaged with care. Clean, wrap or crate for storage and handling, and deliver to Owner as directed.
 - 1. Markerboards
 - 2. Projection screens
 - 3. Projectors
 - 4. Tack boards
 - 5. Lecturns.
 - 6. Valves
 - 7. Plumbing fixtures
 - B. Disposal: Removed material, other than items directed to be salvaged or indicated to be reused, become Contractor's property upon removal, and shall be removed from site. Debris shall be picked up and disposed of, off site, by Contractor promptly and continuously as Work progresses, and not allowed to accumulate. Sprinkle the debris to prevent dust nuisance. Secure and pay for required hauling permits and pay dumping fees and charges. Contractor shall make every reasonable effort to divert debris to recycling or reuse facilities.

END OF SECTION

SECTION 03 01 30

CONCRETE CLEANING

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Chemical cleaning of existing concrete surfaces.
 - B. Related Sections
 - 1. Section 03 35 00, Concrete Floor Finishing
 - 2. Section 03 35 35, Concrete Sealer.
 - 3. Section 32 13 13, Concrete Sitework

1.02 SUBMITTALS

- A. Data on cleaning solutions.
- B. Product Data: Mechanical cleaning methods including abrasive blasting, grinding, and sanding that remove dirt by abrasion.
 - 1. Include protection of surrounding materials on building and Project site, and control of dust during operations. Describe in detail materials, methods, and equipment to be used.
- C. Manufacturers' application instructions.
- 1.03 QUALITY ASSURANCE
 - A. Pre-installation Conference
 - 1. Convene pre-installation conference one week before starting Work of this Section.
 - 2. Require attendance of parties directly affecting Work of this Section.
 - 3. Review conditions and proposed procedures.
 - B. Mockups: Prepare mockups on existing surface under same weather conditions to be expected during remainder of the Work.
 - 1. Clean an area approximately 25 square feet for chemical cleaning <100 square feet for mechanical cleaning.
 - a. Chemical methods.
 - b. Mechanical cleaning methods as recommended by Architect:
 - 1) Abrasive blast cleaners (grit size as determined on site)
 - 2) Bead blaster cleaners (glass bead size as determined on site).

1.04 DELIVERY, STORAGE AND HANDLING

A. Furnish materials in manufacturer's packaging including instructions for use.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Do not wash down or wet surfaces when temperature may drop below 40 degrees F within twenty-four hours.
- 1.06 SEQUENCING/SCHEDULING
 - A. Perform cleaning of surfaces during hours approved by the Owner.

PART 2 - PRODUCTS

- 2.01 CLEANING MATERIALS
 - A. Products of the following manufacturers form the basis for design and quality intended.
 1. Prosoco Inc., Kansas City, KS. Product: SURE-KLEAN Light Duty Concrete Cleaner.
 - B. Or equal as approved in accordance with Division 01, General Requirements for substitutions.
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Verify that surfaces to be cleaned are ready for Work of this Section.
 - B. Beginning of installation means acceptance of existing surfaces and conditions.
- 3.02 PREPARATION
 - A. Protect elements surrounding work of this Section from damage.
 - B. Carefully remove and store fixtures, fittings, finishing hardware, accessories or other items that may be adversely affected by cleaning materials.
 - C. Close off, areas, materials and surfaces not receiving work of this Section to protect from damage.
 - D. Provide for thorough ventilation.
- 3.03 CLEANING EXISTING CONCRETE
 - A. Cleaning: Minimum percent solution for specific condition of concrete surfaces to remove existing stains, waxes and coatings and leave surface with uniform, natural color and texture.
 - B. Apply test sections to determine minimum percent solution.
 - C. Avoid contact with skin and eyes per manufacturer's instructions.

D. Complete cleaning operation with clean water rinse or special neutralizing rinse to ensure complete removal of all acidic ingredients.

3.04 CLEANING

- A. As work proceeds and on completion, remove excess mortar, droppings, smears, stains, efflorescence or other unsightly excess resulting from Work of this Section.
- B. Clean surrounding surfaces.

END OF SECTION

SECTION 03 01 31

CONCRETE REPAIR

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Concrete repair.
 - B. Preparation of concrete and application of repair materials.
 - C. Repair of concrete internal reinforcement.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ASTM A82 Cold-Drawn Steel Wire for Concrete Reinforcement.
 - C. ASTM A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - D. ASTM C33 Concrete Aggregates.
 - E. ASTM C150 Portland Cement.
 - F. ASTM C881 Epoxy-Resin Base Bonding Systems for Concrete.
 - G. AWS D1.4 Structural Welding Code for Reinforcing Steel.
- 1.03 SUBMITTALS
 - A. Product Data: Include material descriptions, chemical composition, physical properties, test data, and mixing and application instructions.
 - B. Qualification Data: For installers to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.
 - C. Manufacturer's certificates that products meet or exceed specified requirements.
 - D. Procedures of repairing and patching concrete walls.
- 1.04 QUALITY ASSURANCE
 - A. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.
 - B. Store cementitious materials off the ground, under cover, and in a dry location.

- C. Submit Design of reinforcement splices for review by the Structural Engineer of Record.
- D. Welding: AWS D1.4.
- 1.05 DELIVERY AND STORAGE
 - A. Deliver products to site and store in dry location.
- 1.06 PROJECT RECORD DOCUMENTS
 - A. Accurately record actual locations of concrete and reinforcement repair, type of repair, splices and mix used.
- PART 2 PRODUCTS
- 2.01 PATCHING MATERIALS
 - A. Epoxy Resin: Two-part epoxy adhesive meeting the following minimum characteristics: ASTM C881, Type IV, by SEALTIGHT REZI WELD or equal.

Characteristic

Results

Bond Strength	1,000 psi
Tensile Strength	7,000 psi
Elongation at Break	1 percent minimum
Compressive Strength at 7 days	10,000 psi minimum

- B. Bonding Agent: Polyvinyl acetate emulsion, dispersed in water while mixing, non-coagulant in mix, water resistant when cured.
- C. Portland Cement: ASTM C150, Type II.
- D. Sand: ASTM C33; uniformly graded, clean.
- E. Water: Clean and potable.
- F. Cleaning Agent: Commercial muriatic acid of 10 percent strength.
- 2.02 REINFORCEMENT MATERIALS
 - A. Reinforcing Steel: ASTM A615, 40 yield grade billet-steel deformed bars, uncoated finish.
 - B. Stirrup Steel: ASTM A615 40 ksi yield grade.
 - C. Dowels: ASTM A615; 60 ksi yield grade, plain steel, uncoated finish.

2.03 MIXING EPOXY MORTARS

- A. Mix epoxy mortars in accordance with manufacturer's instructions for purpose intended.
- B. Mix components in clean equipment or containers. Conform to pot life and workability limits.

PART 3 - EXECUTION

- 3.01 EXAMINATION
 - A. Verify that surfaces are ready to receive work.
 - B. Beginning of installation means installer accepts existing surfaces.

3.02 PREPARATION

- A. Clean concrete surfaces of dirt, laitance, corrosion or other contamination; wire brush using water or appropriate cleaning material.
- B. Flush out cracks and voids with water to remove laitance and dirt. Chemically neutralize by rinsing with water.
- C. Provide temporary entry ports spaced to accomplish movement of fluids between ports, no deeper than the depth of the crack to be filled. Limit port size diameter to be no greater than the thickness of the crack. Provide temporary seal at concrete surface to prevent leakage of adhesive.
- D. For areas patched with epoxy mortar, remove broken and soft concrete. Remove corrosion from steel. Clean surfaces mechanically; wash and rinse with water.
- E. Sandblast clean the exposed reinforcement steel surfaces. Mechanically cut away damaged portions of bar and repair.

3.03 REPAIR WORK

- A. Repair exposed structural, shrinkage and settlement cracks of concrete by injection-epoxy resin adhesive method. Repair cracks greater than 0.06 inches and less than 0.25 inches.
- B. Repair spalling of concrete by the bonding agent and cementitious paste method. Fill voids flush with surface.
- C. Patch honeycombing and repair cracks in concrete greater than 0.25 inches by the epoxy-mortar method.
- D. Repair reinforcement by welding new bar reinforcement to existing reinforcement. Strength of welded splices and reinforcement to exceed original stress values.

3.04 INJECTION - EPOXY RESIN ADHESIVE

- A. Inject adhesive into prepared ports under pressure using equipment appropriate for particular application.
- B. Begin injection at lower entry port and continue until adhesive appears in adjacent entry port. Continue from port to port until entire crack is filled.
- C. Remove temporary seal and excessive adhesive.
- D. Clean surfaces adjacent to repair and blend finish.
- 3.05 APPLICATION EPOXY MORTAR
 - A. Trowel apply mortar mix. Tamp into place filling voids at spalled areas.
 - B. For patching honeycomb, trowel mortar onto surface, working into honeycomb to bring surface flush with surrounding area. Finish trowel surface to match surrounding area.
 - C. Cover exposed steel reinforcement with epoxy mortar; feather edges to flush surface.
- 3.06 FIELD QUALITY CONTROL
 - A. Field inspection and testing will be performed under provisions of Division 01, General Requirements.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 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. Related sections:
 - a. 32 13 13 Concrete Paving
 - b. 32 13 16 Site Concrete Paving
- B. Latest edition of American Concrete Institute, ACI 318 and Manual of Concrete Practice (inclusive of all Parts).
- C. If conflict occurs between the Contract Drawings, the Project Manual, ACI 318, and the Manual of Concrete Practice, the most stringent takes precedence.

1.02 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Sections:
 - 1. Division 32 Section "Concrete Paving" for concrete pavement and walks.
 - 2. Division 32 Section "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.03 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
- B. Shore: Vertical or inclined support members designed to carry the weight of formwork, concrete, and construction loads above.
- C. Strength Test: The average of the strengths of at least two 6 by 12 inch cylinders or at least three 4 by 8 inch cylinders made from the same sample of concrete and tested at 28 days or at test age designated for determination of specified compressive strength of concrete.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
 - 2. Include qualified strength test records if design mixture is based on field experience.
 - 3. Include results of trial mixtures if design mixture is based on trial mixtures.
 - 4. Include results of modulus of elasticity tests on trial mixtures.
 - 5. Design mixture to be signed and sealed by a professional Civil or Structural Engineer licensed in the State in which the Project is constructed.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installers.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Curing compounds.
 - 6. Floor and slab treatments.
 - 7. Bonding agents.
 - 8. Vapor retarders, including subbase materials.
 - 9. Semirigid joint filler.
 - 10. Joint-filler strips.
 - 11. Repair materials.
- D. Material Test Reports: For the following, from a qualified Testing Agency, indicating compliance with requirements:
 - 1. Aggregates.
- E. ICC ES Evaluation Reports: For evidence of Building Code compliance:
 - 1. Mechanical splices and connectors for reinforcing steel.



- F. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
- G. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - 1. Location of construction joints is subject to approval of the Architect
- H. Minutes of preinstallation conference.
- 1.06 QUALITY ASSURANCE
 - A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
 - B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
 - C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
 - D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel." Refer also to CBC 1704A.3 and AWS D1.1.
 - E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5. [Sections 1 through 5 and Section 7, "Lightweight Concrete."]
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - F. Concrete Testing Service: Engage a qualified independent Testing Agency to perform material evaluation tests and to design concrete mixtures.
 - G. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review special inspection and Testing Agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor

and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

- 1.07 DELIVERY, STORAGE, AND HANDLING
 - A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

- 2.01 FORM-FACING MATERIALS
 - A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
 - B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
 - C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiberreinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
 - D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
 - E. Void Forms: Structurally sufficient to support weight of plastic concrete and other superimposed loads.
 - 1. Expanded polystyrene (EPS); ASTM C578, Type XI.
 - F. Chamfer Strips: Wood, metal, PVC, or rubber strips (19 by 19 mm).
 - G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
 - H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2.02 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60 percent.
- B. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- C. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, Grade 60, deformed.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.04 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Dowel Bar Sleeves: Circular PVC sleeve, sealed one end, dowel bar embedment plus 1 inch in length, and 1/16 inch annular space inside diameter.
- C. Deformed Bar Anchors: ASTM A1064/A1064M, deformed steel wire; AWS D1.1/D1.1M, Type C.
- D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
- E. Mechanical Splices and Connectors: Comply with ACI 318 and ACI 439.3R, Type I and Type II.
 - 1. Furnish splicing and connector system with current ICC ES Evaluation Report.
- F. Punching Shear Reinforcing for Slabs: Comply with ACI 318 and ACI 421.1R.
 - 1. Furnish shear reinforcing system with current ICC ES Evaluation Report

2.05 CONCRETE MATERIALS

A. Regional Materials: Provide concrete that has been manufactured within 500 miles of Project site from aggregates and/or cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

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- B. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C150/C150M, Type I or Type II. Supplement with the following:
 - a. Fly Ash: ASTM C618, Class F.
- C. Normal-Weight Aggregates: ASTM C33/33M, Class 1N coarse aggregate, wellgraded. Provide aggregates from a single source.
 - 1. Maximum Coarse Aggregate Size: 1-1/2 inches nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Lightweight Aggregate: ASTM C330/C330M, expanded shale, presize before firing, 3/4-inchnominal maximum aggregate size.
- E. Water: ASTM C 94/C94M.

2.06 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C260/C260M.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 - 2. Retarding Admixture: ASTM C494/C494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.

2.07 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E1745, Class A, 15 mil. Include manufacturer's recommended adhesive or pressure-sensitive tape.
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- C. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C33/C33M for fine aggregates.

2.08 FLOOR AND SLAB TREATMENTS

- A. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.
- B. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

2.09 LIQUID FLOOR TREATMENTS

- A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.10 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlappolyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

2.11 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D2240.
- C. Reglets: Fabricate reglets in concrete to receive flashing from other trades of not less than 0.022-inch thick galvanized-steel sheet. See Division 07 Section "Sheet Metal Flashing and Trim". Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

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D. Dovetail Anchor Slots: Provide as shown on Drawings. Hot-dip galvanized-steel sheet, not less than 0.034-inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.12 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C109/C109M.
- C. Epoxy Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.13 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete indicated on drawings, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent Testing Agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.



- B. Modulus of Elasticity: Modulus of elasticity tests (ASTM C469/C469M) shall be performed on laboratory trial mixtures for each concrete strength, each concrete mix design and for each aggregate source. Modulus of elasticity to be tested using servo controlled electromechanical United machines or servo controlled hydraulic Satec machines. Maintain rate of loading to 35 ± 4 psi in lieu of that specified in ASTM C469/C469M.
 - 1. The modulus of elasticity (psi) at 28 days shall be a minimum of 100% of the target modulus of elasticity.
 - 2. Target modulus of elasticity (psi):
 - a. For $f'_c \le 6,000$ psi: 57,000 $(f'_c)^{1/2}$
 - b. For $f'_c > 6,000$ psi: 40,000 $(f'_c)^{1/2} + 1x10^6$,
 - c. f'_c is the specified concrete strength in psi at 28 days.
 - 3. A modulus of elasticity test shall be the average modulus of elasticity from a set of two (minimum) specimens obtained from same sample.
 - 4. Use a qualified independent Testing Agency for preparing and reporting results of modulus of elasticity tests.
- C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 15 percent maximum
 - a. Fly ash is not permitted in suspended slabs.
- D. Water-soluble chloride ion content shall be determined by ASTM C1218/C1218M at age between 28 and 42 days. Submit documentation verifying compliance. Limit water-soluble, chloride-ion content in hardened concrete to:
 - 1. 1.00 percent by weight of cement for mild-reinforced concrete.
 - 2. 0.06 percent by weight of cement for post-tensioned concrete.
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.14 FABRICATING REINFORCEMENT

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

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2.15 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117, unless specified otherwise in the Contract Documents.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete, unless otherwise indicated on Drawings.



- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.02 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."

3.03 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.04 VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.
- B. Granular Course: [Cover vapor retarder with][Place vapor retarder over]4-inch bed of granular fill, material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.
 - 1. Fine-Graded Granular Material: Place and compact a 1/2-inch layer of finegraded granular material over granular fill.

3.05 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Weld reinforcing bars according to AWS D1.4/D1.4M, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.06 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.

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- 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
- 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
 - a. Perform saw-cutting before concrete starts to cool, as soon as the concrete surface is firm enough not to be torn or damaged by the blade, and before random drying-shrinkage cracks can from in the concrete slab. Joints produced by conventional dry- or wet-cut process shall be made within 4 hours in hot weather and within 12 hours in cold weather after the slab has been finished.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 - 2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint or use PVC dowel bar sleeve.

3.07 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Deviation from cross sectional thickness of suspended slabs shall not exceed $\pm 1/4$ ".
 - 5. Deviation from elevation of suspended slabs before removal of supporting shores shall not exceed +3/8" nor -1/4".
 - 6. Slope surfaces uniformly to drains where required.
 - 7. Begin initial floating using bull floats or darbies to form a uniform and opentextured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- F. Hot-Weather Placement: Comply with ACI 301 and as follows:
 - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided



water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

 Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.08 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.09 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
 - 1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots,
and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

- 1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, or built-up or membrane roofing.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 - 2. Finish surfaces to the following tolerances, according to ASTM E1155, for a randomly trafficked floor surface:
 - Specified overall values (SOV) of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values (MLV) of flatness, F(F) 17; and of levelness, F(L) 15.
 - Specified overall values (SOV) of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values (MLV) of flatness, F(F) 24; and of levelness, F(L) 17; for surfaces to receive thin-set flooring.
 - 3. For floor installations 10,000 sq. ft. or less in total project area, finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch (90 percent compliance) in accordance to ACI 117 Section 4.8.
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
 - 1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- G. Slip-Resistive Finish: Before final floating, apply slip-resistive aluminum granule finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
 - 1. Uniformly spread 25 lbs./100 sq. ft. of dampened slip-resistive aluminum granules over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.



- 2. After broadcasting and tamping, apply float finish.
- 3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aluminum granules.
- H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:
 - 1. Uniformly apply dry-shake floor hardener at a rate of 100 lbs./100 sq. ft. unless greater amount is recommended by manufacturer.
 - 2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
 - 3. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.11 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

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- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moistureretaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moistureretaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.12 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
 - 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 - 2. Do not apply liquid to concrete sooner than that recommended by manufacturer.

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3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

3.13 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
 - 4. Repair technique shall be tested on a mockup or surface to be concealed later, before repairing surfaces exposed to view, for approval by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

- 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
- 2. After concrete has cured at least 14 days, correct high areas by grinding.
- 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
- 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
- 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
- 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified Testing Agency to perform field tests and inspections and prepare test reports.
- B. Inspections: Verify and inspect concrete Work as shown on Drawings.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one random composite sample for each 50 cu. yd. of concrete or 2,000 sq. ft. of surface area of slabs of walls, or fraction thereof, of each concrete mixture placed each day.

- a. When frequency of testing will provide fewer than five compressivestrength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
- 2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
- 3. Air Content: ASTM C231/C231M, pressure method, for normal-weight concrete; [ASTM C173/C173M, volumetric method, for structural lightweight concrete;]one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
- 4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
- 5. Unit Weight: ASTM C567/C567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
- 6. Compression Test Specimens: ASTM C31/C31M.
 - a. Mild-Reinforced and Post-Tensioned Slabs and Beams: Cast and laboratory-cure five standard cylinder plus one spare standard cylinder specimens for each composite sample.
 - Cast and field-cure additional standard cylinder specimens to verify concrete strength for removal of shoring and reshoring in multistory construction. Number of field-cured cylinder specimens to be determined by Contractor.
 - Cast and field-cure additional standard cylinder specimens to verify concrete strength for stressing of tendons in post-tensioned construction. Number of field-cured cylinder specimens to be determined by Contractor.
 - b. Shear Walls and Columns: Cast and laboratory-cure five standard cylinder plus one spare standard cylinder specimens for each composite sample.
 - c. Other Concrete Elements: Cast and laboratory-cure four standard cylinder plus one spare standard cylinder specimens for each composite sample.
- 7. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Mild-Reinforced Concrete Slabs and Beams: Test one laboratory-cured specimen at 4 days; one laboratory-cured specimen at 7 days or upon formwork stripping, whichever comes first; one laboratory-cured specimen at 14 days; and two laboratory-cured specimens at 28 days.
 - b. Post-Tensioned Concrete Slabs and Beams: Test one laboratory-cured specimen at age determined by contractor for tendon stressing; one laboratory-cured specimen upon formwork stripping or 7 days, whichever comes first; one laboratory-cured specimen at 14 days; and two laboratory-cured specimens at 28 days.

- c. Shear Walls, Columns and concrete pilaster: Test one laboratory-cured specimen at 7 days, one laboratory-cured specimen at 56 days and one laboratory-cured specimen at 90 days; and two laboratory-cured specimens at 28 days.
- d. Other Concrete Elements: Test two laboratory-cured specimens at 7 days and two laboratory-cured specimens at 28 days.
- e. A compressive-strength test at shall be the average compressive strength from a set of two specimens obtained from same composite and tested at the age indicated.
- 8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 - a. If 28-day compressive-strength test falls below satisfactory levels, strength test the spare cylinder at age determined by the Contractor and average with the strength of the 28-day specimens. The average strength of the three cylinders shall be considered one compressive-strength test.
- 9. Modulus of Elasticity Test Specimens: ASTM C31/C31M.
 - a. Shear walls,columns and concrete pilasters: Cast and field-cure eight two standard cylinder specimens plus two spares for each composite sample.
 - Composite samples (consisting of 10 standard field-cured cylinder specimens) for each concrete strength, each concrete mix design and for each aggregate source, shall be randomly selected from every five floors, with two random composite samples minimum per building.
- Modulus of Elasticity Tests: ASTM C469/C469M. Modulus of elasticity to be tested using servo controlled electromechanical United machines or servo controlled hydraulic Satec machines. Maintain rate of loading to 35 ± 4 psi in lieu of that specified in ASTM C469/C469M.
 - a. Mild-Reinforced and Post-Tensioned Slabs and Beams: Test two fieldcured specimens at 2 days, 4 days, 7 days, 14 days, and 28 days.
 - b. Columns and Shear Walls: Test two field-cured specimens at 7 days, 28 days, 56 days, and 90 days.
 - c. A modulus of elasticity test shall be the average modulus of elasticity from a set of two specimens obtained from same composite sample and tested at age indicated.
 - d. If modulus of elasticity of two specimens varies by more than 15% a spare cylinder shall be tested. The average modulus of elasticity of three specimens shall be considered the modulus of elasticity.
 - e. Modulus of elasticity tests are required for each concrete strength, each concrete mix design and for each aggregate source.



- 11. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing.
 - a. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete Testing Agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for each age tested.
 - b. Reports of modulus of elasticity tests shall contain Project identification name and number, mix identification number, specimen identification number, curing and environmental history of specimen, date of test, name of Testing Agency, and plot of the results with age of concrete as the abscissa and modulus of elasticity as the ordinate.
- 12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- 13. Additional Tests: Testing Agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing Agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
- 14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- 15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- D. Measure floor and slab flatness and levelness according to ASTM E1155 within 24 hours of finishing.
- E. Reporting: All testing and inspection reports are to be distributed to IOR, District representative, Architect and Structural Engineer of Record. Any reported failures and/or deviations in construction are to be documented and distributed to all those noted, including DSA.

3.16 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03 30 00

SECTION 03 35 00

CONCRETE FLOOR FINISHING

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Finishing of concrete slabs.
 - B. Surface treatment with concrete combination hardener/sealer at all exposed concrete floors.
 - C. Surface treatment with slip resistant
 - D. Surface treatment with concrete stain.
 - E. Surface treatment with concrete color.
 - F. Related Sections:
 - 1. Section 03 01 30 Existing Concrete Cleaning.
 - 2. Section 03 30 00 Concrete.
 - 3. Section 09 06 00 Schedules for Finishes.
 - 4. Section 32 13 13 Sitework Concrete.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ACI 117-90, ACI 302.1R and ASTM E1155 Determining Floor Flatness and Floor Levelness using the F Number System.
 - C. Local AQMD Air Quality Management District.
 - D. ASTM C779.
 - E. ASTM C979 Pigments for Integrally Colored Concrete.
 - F. ADA Americans with Disabilities Act of 1990, as amended
 1. ADA Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design.
- 1.03 SUBMITTALS
 - A. Product Data: Provide data on finishing agents, product characteristics, compatibility and limitations.
 - B. Manufacturer's Installation Instructions: Indicate criteria for preparation and application.

- C. Certify that product meets AQMD, Local Regulations.
- 1.04 QUALITY ASSURANCE
 - A. Concrete Stain Installer Qualifications: Minimum 5 years'¢ experience with installing stain and color products specified, certified and approved by the manufacturer.
 - B. Concrete Color Installer Qualifications: Minimum 5 years' experience with installing stain and color products specified, certified and approved by the manufacturer.
- 1.05 DELIVERY AND STORAGE
 - A. Deliver and store materials in manufacturer's packaging including application instructions.
- PART 2 PRODUCTS
- 2.01 FINISHES
 - A. Combination Hardener and Sealer: ASTM C779.
 - 1. ASHFORD FORMULA by Curecrete Chemical Co., Springville, UT.
 - 2. SHUR-SEAL by Paul M. Wolff Co, Orange, CA.
 - 3. Chemprobe CT Densifier 629 by Tnemec Company.
 - 4. LIQUI-HARD by W.R, Meadows.
 - 5. Or equal in accordance with Division 01 for Substitutions.
 - 6. Remove all curing compounds before installation.
 - B. Combination Hardener, and Sealer: ASTM C779, Ashford Formula by Curecrete Chemical Co., Springville, UT; Shure-Seal by Paul M. Wolff Co., Orange, CA; Chemprobe CT Densifier 629 by Tnemec Company; LIQUI-HARD by W.R, Meadows, or equal.
 - C. Integral Color Concrete with Sealer: ASTM C979, manufactured by L.M. Scofield and Company, Davis Colors, Inc, Los Angeles, CA, minimum of three (3) colors, or equal in accordance with Division 01, General Requirements. Colors: As selected by Architect
 - D. Stain over Concrete Color/Hardener and Sealer: LITHOCHROME CHEMSTAIN applied to LITHOCHROME Color Hardener and CEMETONE Clear Sealer. Provide 6 colors. Manufactured by L.M. Scofield Company. Colors: As selected by Architect
 - E. Or equal as approved in accordance with Division 01, General Requirements for substitutions.
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Verify site conditions.
 - B. Verify that floor surfaces are acceptable to receive Work of this Section.

- C. Commencement of Work means acceptance of existing conditions.
- D. Remove all curing compounds before installation.
- 3.02 FLOOR FINISHING
 - A. Comply with recommendations in ACI 302.1R for screeding, floating, straightedging, restraightening (with Modified Highway Straightedge) operations and troweling, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
 - B. Float Finish: Consolidate surface with power-driven floats or by hand floating if areas is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth granular texture.
 - C. Trowel Finish: After float finish, minimum 2 trowel operations, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue trowel passes and restraightening (with Modified Highway Straightedge) operations until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - D. For Floor installations 10,000 sq. ft. or less in total project area, finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surfaces does not exceed 1/4" (90 percent compliance).
 - E. Wood float surfaces which will receive quarry tile, ceramic tile or pavers, set in full bed setting system.
 - F. Steel trowel surfaces that will receive carpeting, resilient flooring, thinset ceramic tile, thin set quarry tile, floor sealer or elastomeric coatings, minimum of two trowelings.
 - 1. Exposed concrete surfaces with hardener/sealer: slip resistant surface. Static Coefficient of Friction: ASTM D2047, minimum 0.6 COF for level surface conditions, CBC 11B-302.
 - 2. Surfaces scheduled to receive elastomeric coatings: Fine-hair broom surface.
 - G. Steel trowel surfaces scheduled to be exposed.
 - H. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains.
- 3.03 FLOOR SURFACE TREATMENT
 - A. Hardeners cannot be installed over curing compounds. Hardeners are applied to min.
 7-day cured concrete (For wet concrete)
 - B. Apply combination hardener and sealer to interior and exterior concrete slab surfaces as scheduled in accordance with manufacturer's instructions. Apply minimum two coats after first coat is dry and acceptable to manufacturer. Penetrating Sealer: Above-grade concrete walks and concrete.

- 1. For Wet Concrete:
 - a. Apply hardener sealer per manufacturer's instructions immediately following the finishing operations and as soon as surface is firm enough to walk on.
 - b. Keep the entire surface wet with hardener and sealer for 30 minutes.
 - c. Lightly mist the surface with water when hardener sealer begins to dry and becomes slippery,
 - d. As hardener-sealer begins to dry into the surface and becomes slippery underfoot, flush the surface with water and squeegee surface totally dry to remove any excess material.
- 2. For Cured Concrete
 - a. Clean concrete surfaces in accordance with Section 03 01 30.
 - b. Thoroughly clean surfaces, sweep areas to be treated with fine bristle broom. Hose floor to remove dust and dirt.
 - c. Clean concrete surfaces with manufacturer's recommended remover.
 - d. Apply material to dry surfaces or damp per manufacture's instructions. Dispose of standing puddles.
 - e. Uniformly distribute material at a minimum rate of 200 square feet per gallon.
- C. Concrete Stain: Apply chemical stain.
- D. Apply slip resistant finish in accordance with manufacturer's instructions on scheduled floor surfaces.
 - 1. Float and trowel concrete once and allow to set until surface will support finisher's supports.
 - 2. Uniformly distribute grains over surface at the rate of 50 pounds per 100 square feet.
 - 3. Imbed grains with a light wood float.
 - 4. Apply a light steel float. Do not trowel excessively. Grains shall remain visible in a uniform pattern.

3.04 STAINED CONCRETE

- A. Stain concrete and Sealer:
 - 1. Clean, sweep and pressure wash concrete surface with commercial detergent. Rinse thoroughly after cleaning.
 - 2. Apply chemical stain to sufficiently cured concrete surface in accordance with strict written instructions of the manufacturer. Colors: as selected by the Architect
 - 3. Apply a minimum of two separate chemical stain applications, full strength (undiluted) at a rate of 150-200 square feet per gallon per application.
 - 4. Apply two coats of clear sealer in accordance with the written instructions of the manufacturer.
- B. Stained Concrete over Color Hardener, and Sealer:
 - 1. Finish concrete and dry shake Lithochrome Color Hardener on freshly placed concrete.
 - 2. Apply Lithochrome Chemstain concrete stain in strict manufacturer's instruction and in formulas as recommended by the manufacturer for specific colors. Colors: as indicated.

- 3. Apply 2/3 of specified application rate to freshly floated concrete surface. Bleed water shall not be present during or following application of first and second shake.
- 4. Do not throw dry-shake, distribute evenly by hand or mechanical spreader designed to apply floor hardeners. Consult manufacturers for recommended mechanical spreaders.
- 5. As soon as dry-shake material has absorbed moisture, indicated by uniform darkening of surface, mechanically float concrete surface a second time, just enough to bring moisture from base slab through dry-shake color hardener.
- 6. Immediately following second floating, apply remaining 1/3 of specified application rate. If applied by hand, broadcast in opposite direction of first application for a more uniform coverage. If a mechanical spreader is used, apply the same manner as previously described.
- 7. As soon as dry-shake material has absorbed moisture, mechanically float concrete surface a third time.
- 8. Do note add water to the surface.
- 9. As surface further stiffens, remove float blades to expose the power finishing blades or raise combination blades slightly. Flat trowel surface to remove marks and pinholes.
- 10. Further troweling operation can be done, each time raising blades, until desired texture or finish is obtained.
- 11. Do not burnish trowel colored surface floor hardeners.
- 12. Apply two coats of clear sealer in accordance with the written instructions of the manufacturer. Apply immediately after floor surface has hardened sufficiently so that application of curing and sealing compound will not mar surface. Apply uniformly over entire surface at coverage rate recommended by manufacturer and meeting or exceeding the moisture retention requirements of ASTM C309.

3.05 COLORED CONCRETE

- A. Conform to On-Site Concrete Sidewalks and Concrete Areas procedures specified in this Section except where specified otherwise in this paragraph.
- B. Approved Manufacturer: Davis Colors, Inc., Los Angeles, CA, L.M. Scofield Company, Los Angeles, CA., or approved equal as approved in accordance with Division 01, General Requirements for Substitutions.
- C. Materials: Cement coloring dye for exposed concrete [exterior concrete sidewalks], ASTM C979; integral, with natural and synthetic pigments and no artificial adulterants or fillers. Color as selected by the Architect from manufacturer's standard list.
- D. Weight Required: As recommended by the manufacturer for the color selected, in pounds of dye per sack of cement in the total batch. Add pigment by weight only, no visual proportioning permitted.
- E. Rinse mixer drum thoroughly before batching colored concrete.
- F. Add coloring agent directly to mixer at charging or mixing speed of 50 to 100 RPM for 5 to 10 minutes. Constant ratio of coloring agent to cement and materials required.

G. Curing: Cure colored concrete surfaces strictly in accordance with the coloring material manufacturer's recommendations. Apply matching color sealer in accordance with L. M. Scofield Curing Compound for concrete stain

3.06 HARDENER SEALER

- A. Starseal PS Clear FSR System: Apply hardener sealer to interior [exterior] concrete slab surfaces as scheduled in accordance with manufacturer's instructions. Apply minimum two coats after first coat is dry and acceptable to manufacturer.
 - 1. For Freshly Placed Concrete:
 - a. Apply hardener sealer at full strength to the concrete immediately after the final finishing and gauging water is absorbed, at 200-300 sq. ft./gal (5.0-7.5m2/L) by sprayer or applicator.
 - b. Keep the surface wet with hardener sealer by reapplying to dry spots, but do not puddle.
 - c. If gel forms on the surface it should be rinsed with clean water to remove excess material and alkali. If a white film starts to form the material should be rinsed with clean water immediately.
 - d. Surface must be kept damp over 72 hours. Do not puddle water on concrete only to keep moist with a fine spray of water periodically or apply a plastic film. Apply burlap or curing blankets that are wetted to keep them moist must be applied over the surface to cure.
 - e. Do not subject the floor to traffic until dry.
 - f. After the 72-hour curing period, the surface must be burnished. The surface must be free of all standing water and dry.
 - g. Apply fixative by sprayer, roller or applicator at 400-600 sq. ft./gal. to floor previously treated with hardener sealer. Apply 12-24 hours after hardener sealer application. Rinse off immediately after application. There must be a person or two with either a wet mop and clean water or a walk behind floor scrubber that has water in it and a squeegee immediately behind the person applying the Fixative. Do not allow the Fixative to dry. If diamond polishing, polish to achieve the desired level of gloss 4-5 hours after application of fixative.
 - h. Finish coat should not be diluted or altered. Apply with low-pressure (40-psi) airless spray equipment. Sprayer should be fitted solvent resistant hoses and gaskets. If using brushes or rollers care should be taken to ensure that enough solution is applied.
- B. Finish coat should be applied in a single saturating application with sufficient material applied so that the surface remains wet for a few minutes before penetration into the concrete. Surface residues, pools and puddles should be broomed out thoroughly until they completely penetrate into the surface. Additional light coats may be required until the material no longer absorbs into the concrete. Do not over apply. After thoroughly drying the floor must be burnished with a high speed burnishing machine and a black stripping pad to remove excess Finish Coat form the surface.

3.07 DRY-SHAKE COLOR HARDENER

A. Apply 2/3 of specified application rate to freshly floated concrete surface. Bleed water shall not be present during or following application of first and second shake.

- B. Do not throw dry-shake; distribute evenly by hand or mechanical spreader designed to apply floor hardeners. Use mechanical spreaders as recommended by manufacturer.
- C. As soon as dry-shake material has absorbed moisture, indicated by uniform darkening of surface, mechanically float concrete surface a second time, just enough to bring moisture from base slab through dry-shake color hardener.
- D. Immediately following second floating, apply remaining 1/3 of specified application rate. If applied by hand, broadcast in opposite direction of first application for a more uniform coverage. If a mechanical spreader is used, apply the same manner as previously described.
- E. As soon as dry-shake material has absorbed moisture, mechanically float concrete surface a third time.
- F. Do not add water to the surface.
- G. Begin sandblasted operations immediately after applying dry-shake colored hardener, according to manufacturer'¢s written instructions, including application of powder antiquing release agent.
 - 1. Patterns and Colors: Refer to Section 09 06 00.

3.08 FIELD QUALITY CONTROL TESTING

- A. Straightedge Tolerance: Five consecutive measurements in compliance with specified tolerance is acceptable.
- B. Repair for slabs-on-grade failing to meet specified tolerances (out-of-tolerance): surface repair, grinding, planing, retopping, cementitious self-leveling underlayment; at no additional cost to the Owner.

3.09 PROTECTION

- A. Protect treated concrete surfaces from damage by construction activities with durable temporary coverings offering floor protection until acceptance by the Architect. Damaged to floor finishes shall be repaired by the Contractor at no cost to the Owner.
- B. Flooring shall be protected as follows:
 - 1. Protect entire floor where area anticipated to be affected. Submit layout of protected area to Architect for approval.
 - 2. Loose lay rosin-sized building paper over floor area; tape all seams; do not tape or otherwise attach to floor.
 - 3. Over building paper, loose lay 10 mil polyethylene sheet; tape all seams. Do not tape or otherwise attach to floor.
 - 4. Lay sheets of minimum 1/4 inch thick tempered hardboard, butt edges and tape to prevent dislodging.
 - 5. If scissor lifts or other heavy equipment will be used on floor, use 3/4" plywood.
 - 6. Take other precautions as necessary to prevent damage in addition to requirements above. Submit to Architect for approval.



END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

05 31 00 Steel Decking

05 50 00 - Metal Fabrication Closeout

05 51 10 - Metal Stairs

09 96 00 - High-Performance Coatings

- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Structural steel.
 - 2. Grout.

B. Related Sections:

- 1. Division 05 Section "Steel Decking" for field installation of shear connectors through deck.
- 2. Division 05 Section "Metal Fabrications" for miscellaneous steel fabrications and other metal items not defined as structural steel.
- 3. Division 05 Section "Metal Stairs."
- 4. Division 09 painting Sections and Division 09 Section "High-Performance Coatings" for surface-preparation and priming requirements.

1.03 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SFRS" or elements along grid lines designated as "SFRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows: 5015021-100 STR Palomar College Escondido - HVAC Lab 10.04.2018

- 1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
- 2. Welded built-up members with plates thicker than 2 inches (50 mm).
- 3. Column base plates thicker than 2 inches (50 mm).
- D. Protected Zone: Structural members or portions of structural members of the SFRS indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
- E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
 - 5. Identify members and connections of the seismic-load-resisting system.
 - 6. Indicate locations and dimensions of protected zones.
 - 7. Identify demand critical welds.
- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing. For demand critical welds include the following:
 - 1. One or more combination of welding variables (e.g. power source, volt, amp, travel speed, etc.) that produces heat input within the range used for the WPS Heat Input Envelope Test.
 - 2. Electrode manufacturer and trade name.
- 1.05 INFORMATIONAL SUBMITTALS
 - A. Qualification Data: For qualified Installer.
 - B. Welding certificates.



- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural steel, including chemical and physical properties.
- E. Product Test Reports: For the following:
 - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 2. Direct-tension indicators.
 - 3. Tension-control, high-strength bolt-nut-washer assemblies.
 - 4. Shear stud connectors.
 - 5. Shop primers.
 - 6. Nonshrink grout.
- F. Source quality-control reports.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category [ACSE][CSE].
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
 - 1. Welders and welding operators performing work on bottom-flange, demandcritical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
- D. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC 303.
 - 2. AISC 341 and AISC 341s1.
 - 3. AISC 358.
 - 4. AISC 360.
 - 5. RCSC "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - 6. AWS D1.1/D1.1M.
 - 7. AWS D1.8/D1.8M.
- E. Preinstallation Conference: Conduct conference at Project site.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - 1. Fasteners may be repackaged provided Owner's Testing Agency observes repackaging and seals containers.
 - 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.08 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
 - 1. W-Shapes: 60 percent.
 - 2. Channels, Angles, M, S-Shapes: 60 percent.
 - 3. Plates and Bars: 25 percent.
 - 4. Cold-Formed Hollow Structural Sections: 25 percent.
 - 5. Steel Pipe: 25 percent.
 - 6. All Other Steel Materials: 25 percent.
- B. W-Shapes: ASTM A 992/A 992M.
- C. Channels, Angles, M-, S-Shapes: ASTM A 36/A 36M.

- D. Plates and Bars: ASTM A 36/A 36M, typical; ASTM A 572/A 572M, Grade 50, when used in SLRS connection (345).
- E. Cold-Formed Hollow Structural Sections: ASTM A 500 Grade B (46ksi for rectangular shapes, and 42ksi for round shapes), structural tubing.
- F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
 - 1. Finish: Black [except where indicated to be galvanized].
- G. Welding Electrodes: Comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish; where indicated on Drawings.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
 - 1. Finish: Hot-dip or mechanically deposited zinc coating. All threaded components of the fastener assembly must be galvanized by the same process. Mixing high-strength bolts that are galvanized by one process with nuts that are galvanized by the other is not permitted.
 - 2. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating finish.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish: Plain.
- E. Shear Connectors: ASTM A 29, Grades 1010 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

- F. Headed Anchor Rods: ASTM F 1554, Grade 36, typical; ASTM F 1554, Grade 55, weldable, when used in SLRS; straight.
 - 1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
 - 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 3. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
 - 4. Finish: Plain.
- G. Threaded Rods: ASTM A 36/A 36M.
 - 1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
 - 2. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
 - 3. Finish: Plain.
- H. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
- I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.
- J. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.
- K. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement along one or two axes.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product.
 - 2. Mating Surfaces: PTFE and PTFE.
 - 3. Coefficient of Friction: Not more than 0.06 at 2,000 psi bearing pressure.
 - 4. Design Bearing Pressure: Not greater than 2,000 psi (13.7 MPa).
- 2.03 PRIMER
 - A. Low-Emitting Materials: Paints and coatings 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", including 2004 Addenda.
 - B. Primer: Comply with Division 09 painting Sections and Division 09 Section "High-Performance Coatings."
 - C. Primer: SSPC-Paint 25, Type II, zinc oxide, alkyd, linseed oil primer.
 - D. Galvanizing Repair Paint: ASTM A 780.

2.04 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.05 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
 - 1. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
 - 4. Mark and match-mark materials for field assembly.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes (not by burning) perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning."
- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Baseplate Holes: Cut, drill, or punch holes (not by burning) perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.06 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened unless noted otherwise on Drawings.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M where noted by structural for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.07 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 - 2. Surfaces to be field welded.
 - 3. Top flange of beams supporting steel decking.
 - 4. Surfaces to be high-strength bolted with slip-critical connections.
 - 5. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 - 6. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
 - 2. SSPC-SP 3, "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.08 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
 - 1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
 - 1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Determine, furnish and install all temporary supports, such as temporary guys, beams, braces, falsework, cribbing or other elements required for the erection operation. These temporary supports shall be sufficient to secure the bare structural steel framing or any portion thereof against loads that are likely to be encountered during erection, including those due to wind and those that result from erection operations. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.03 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other

surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

- 1. Level and plumb individual members of structure.
- 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened unless noted otherwise on Drawings.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.05 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified independent Testing Agency to inspect field welds and high-strength bolted connections and prepare test reports.
- B. Inspections: Verify and inspect structural steel Work as shown on Drawings.
- C. Bolted Connections: Bolted connections will be tested and inspected according to RCSC "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."



- D. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
 - 1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at Testing Agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
- E. SFRS Connections: Test and inspect SFRS connection elements as indicated in accordance to AISC 341, AWS D1.1/D1.1M and AWS D1.8/D1.8M.
- F. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - 1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Testing Agency, where warranted, may select a reasonable number of additional studs to be subjected to the bend tests.
- G. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.06 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.
- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

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SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Load-bearing cold-formed structural steel studs.
- B. Interior wall framing using Cold Formed Metal Framing at plumbing walls, wall openings and cabinet-supporting walls.
- C. Formed steel accessories.
- D. Related Sections
 - 1. Section 061600 "Sheathing."
 - 2. Section 0721 00 "Building Insulation."
 - 3. Section 092216 "Non-Structural Metal Framing."

1.02 REFERENCES

- A. AISI American Iron and Steel Institute
 - 1. S100 Design of Cold-Formed Steel Structural Members.
 - 2. S200 Cold-Formed Steel Framing General Provisions.
 - 3. S211 Wall Stud Design.
 - 4. S212 Header Design.
 - 5. S213 Lateral Design.
- B. ASTM International
 - 1. A 1003 Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated.
 - 2. C 645 Nonstructural Steel Framing Members.
 - 3. A653/A653M Steel Sheet, Zinc-Coated (galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 - 4. C 754 Installation of Steel Framing Members.
 - 5. C955 Load-Bearing Steel Studs, Runners, and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
 - 6. C 1513 Steel Tapping Screws for Cold-Formed Steel Framing Connections.
- C. AWS D1.3 American Welding Society, Structural Welding Code, Sheet Steel.
- D. CBC California Building Code 2013, Chapter 22A
- 1.03 SUBMITTALS
 - A. Provide product data on standard framing members. Describe materials and finish, product criteria, limitations and properties.

- B. Mill certificates: signed by the steel sheet producer indicating steel sheet complies with requirements.
- 1.04 QUALITY ASSURANCE
 - A. Manufacturer: Company specializing in steel studs framing and components with five years minimum experience.
 - B. Welding: welders certified by AWS.

PART 2 - PRODUCTS

- 2.01 FRAMING MATERIALS
 - A. Studs: ASTM A1003, Structural Grade 50, Type H (ST50H), sheet steel, formed to "wide flange" shape or "C" shape, punched web, 16 gauge (0.056", SSMA designation 54) thick unless noted otherwise on drawings, 50 ksi steel unless noted otherwise on drawings, sizes required to conform to details and scheduled wall thicknesses, and as required for structural performance. Studs shall be rolled from new sheet steel and shall not be produced from re-rolled steel.
 - 1. Properties: As listed in manufacturer's standard tables for applicable grade of steel and sizes.
 - 2. Conform to AISI S100 and AISI S200.
 - 3. Coating: Zinc coated per ASTM A653, G60.
 - B. Track: ASTM A1003, Structural Grade 50, Type H, sheet steel, channel shaped, deep leg, 16 gauge (0.056", SSMA designation 54) thick unless noted otherwise on drawings, 50 ksi steel unless noted otherwise on drawings, solid web, long leg at ceilings, profile to produce snug fit over adjacent components.
 - 1. Conform to S100 Design of Cold-Formed Steel Structural Members.
 - 2. Approved pre-fabricated slotted slip track for top of wall: CEMCO Slotted Track (CST) 16 gauge, ICC ESR-2012 or equal as approved in accordance with Division 01, General Requirements for substitutions.
 - 3. Provide stand-off washers for fasteners.
 - 4. Install in accordance with manufacturer's recommendations and fire rating requirements.
 - 5. Coating: Zinc coated per ASTM A653, G60 [prime painted].
 - C. Slotted Fire Track: CEMCO FAS Track ASTM A1003, Structural Grade 33, Type H, cut steel channel shaped, deep leg, 16 gauge (0.056") thick unless noted otherwise on drawings, 33 ksi steel unless noted otherwise on drawings, solid web, long leg at ceilings, profile to produce snug fit over adjacent components. Track is designed with intumescent fire proofing on both sides of the track. Intumescent material to lap over the top of the track by 0.25" on each side of the track and down each leg 1.18" to an external groove. Slotted fire track shall be listed by UL Fire Resistance Directory as a firestop for the application used.



- D. Fire Strap: CEMCO FAS Strap ASTM A653, Grade 33 with a minimum 33 ksi yield strength to span between flutes of metal decking. Fire strap to have a minimum of a 1-inch wide continuous strip of intumescent running parallel and along each edge of the strap. Fire strap shall be listed by UL Fire Resistance Directory as a firestop for the application used.
- E. Header and Jambs: ClarkDietrich Building Systems, Heavy Duty Studs and Header Brackets.
 - 1. ProX Header, Brady Construction Innovations Inc. or equal where specified.
- F. Stiffener U- Channels and Angles: Minimum Weights as Follows:
 - 1. 3/4 inch .3 pound per foot, cold- or hot-rolled channel.
 - 2. 1-1/2 inches .475 pound per foot, cold-rolled channel.
 - 3. 1-1/2 inches 1.12 pounds per foot, hot-rolled channel.
 - 4. 2 inches 1.26 pounds per foot, hot-rolled channel.
 - 5. 2 inches .59 pound per foot, cold-rolled channel.
 - 6. 1-1/2 x 1-1/2 x 3/16 inch angle.

2.02 ACCESSORIES

- A. Fastening: Self-drilling, Self-tapping Screws, ASTM C954, galvanized, Buildex/Tomarco Type S-12 point, low profile head screws #10 or equal, 1/2 inch long for two layers 16 gauge metal for non load-bearing framing, welded connections for load-bearing framing and for framing of 16 gauge studs and thicker.
 - 1. Welding: In conformance with AWS D1.3, minimum weld size 3/32".
- B. Anchorage Devices, Powder Actuated:
 - 1. Install to conform to the load requirements of this Section and Tables 1, 2, 3 and 4 of ICC-ESR 1663 Hilti. Minimum diameter: 0.145" diameter.
 - a. Utilize tools as recommended by the manufacture in compliance with ICC numbers.
 - b. ICC-ESR 1663 Hilti Inc., Fasteners Manual, Pneumatic, or Powder-Driven Steel Studs and Nails
 - 2. Allowable Loads: Limited 100 lbs. Maximum or 80% of ICC approved values. Testing required, refer to Division 01.
 - 3. Use of Powder actuated fasteners for tension loads is limited to support of minor loads such as suspended acoustical ceilings, ductwork and conduit. Permissible Loads for Ceiling Clip Assembly:
 - Normal-Weight Concrete: Ceiling Clip Assembly, minimum 0.177 inch diameter, minimum penetration 1-1/2 inch. Required Allowable Loads: 90 lbs. or 80 percent of values listed in ICC Report whichever is less: ICC <u>ES-2184</u> unless noted otherwise on drawings.

1) Type CC27ALH42 w/DX KWIK, by Hilti, Inc., Tulsa, OK.

- Lightweight Concrete: Ceiling Clip Assembly, minimum 0.177 inch diameter, minimum penetration 1-1/4 inch. Required Allowable Loads: 90 lbs. or 80 percent of values listed in ICC ES-2184 unless noted otherwise on drawings:
 - 1) Type CC27ALH32, by Hilti, Inc., Tulsa, OK.

- C. Anchorage Devices, Drilled Expansion Anchors:
 - 1. Wedge Type: KWIK Bolt TZ Concrete Anchor, 3/8 to 3/4 inch diameter, ICC ESR-1917, by Hilti Inc., Tulsa, OK.
 - a. Eyebolt HHDCA drill-in anchor for suspended ceilings. Provide minimum ¹/₄-inch size anchor, requires testing refer to Division 01.
 - 2. Adhesive Anchors System:
 - a. For fully grouted CMU, lightweight concrete, construction per ICC ES-1385, Hilti Kwik Bolt 3 (KB3) unless noted otherwise on drawings.
 - b. For Normal Weight concrete with min. compressive of 2000 psi or 4000 psi. Per ICC ESR-3814, Hilti HIT-RE 500-V3 Adhesive Anchor System.
- D. Masonry Anchors: 1/4" diameter, Tapcon with Advance Threadform Technology, heat-treated steel, by Illinois Tool Works/Buildex, ICC-ESR-1671. Slotted Hex Washer Head only where indicated on drawings.
- E. Backings: Located and as indicated on drawings or 6" x 1-1/4" x 14 gauge flush mount backing, preformed with pre-punched screw holes, FLUSH-MOUNT BACKING by Metal-Lite, Inc., Anaheim, CA.
- F. Track Bedding Sealant: Per Section 079200 "Joint Sealants."
- G. Wall finishes: Per Division 09 Finishes.
- 2.03 FINISHES
 - A. Galvanized Finish: Zinc coated per ASTM A653, G60.

PART 3 - EXECUTION

- 3.01 PREPARATION
 - A. Verify that substrate surfaces and building framing components are ready to receive work.
 - B. Beginning of installation means acceptance of existing conditions.
 - C. Layout markings shall not be made with xylene-based inks, paint, or dyes, or with other solvent-based products that may bleed through finishes.
- 3.02 ERECTION OF STUDDING
 - A. Perform work in accordance with, AISI and SSMA/ICC ES 3064P.
 - B. Align floor and ceiling tracks; locate to wall or partition layout. Secure in place with specified fasteners at spacing as indicated on drawings or maximum 32 inches on centers.
 - 1. Set floor track on continuous sealant, each side of track for exterior walls. Sealant type: Butyl Rubber per ASTM C920.



- 2. Track Splices: notch flanges to allow sliding tracks past each another 12". Attach as approved by manufacturer of system.
- C. Place studs at 16 inches oc typically, or 12 inches oc in plumbing walls or as noted on drawings. Connect studs to tracks using fastener or welding method.
- D. No flame (oxyacetylene) torch cutting is permitted, use Plasma Arc cutting to make penetrations for conduit or piping where required.
- E. Construct corners using minimum three studs.
- F. Install double (boxed) studs at each head, jamb and sill of each exterior and interior door and window opening. Extend studs from floor to underside of structure above. Weld all boxed jamb and header members with interrupted 1/8" welds, one inch long at 12 inches on center.
- G. Install 1-1/2 inch standard steel furring channels at right angles to king stud at each door hinge point as permitted by perforations. Weld channel to four studs where possible.
- H. Stiffeners: Install 3/4 inch standard steel furring channel stiffeners within 24 inches of top and bottom runners and at mid height of walls eight feet high. At higher walls, install stiffeners spaced maximum 48 inches on centers. Weld stiffeners to each stud and at laps.
- I. In areas where a finish material occurs on one side of wall only, provide full width bridging or bracing. Two systems permitted:
 - 1. Install 3/4 inch x 16 gauge continuous brace through stud punch-outs, fastened to studs with angle clips welded or screw fastened, spaced as scheduled below.
 - Install 1-1/4 inch x 16 gauge strap, 3/4 inch x 16 gauge or cold-rolled channel continuous across unrestrained edges of studs spaced as scheduled below, screw fastened or welded to each stud, and connected to one blocking member screw fastened or welded to adjacent studs.
- J. Bridging or Bracing Schedule: Stud Size AISI/SSMA

Min. bracing spacing unless noted otherwise on structural drawings.

3-5/8 or 4 in, S-Sections ("c")	2'-6"
3-5/8 or 4 in, T-Sections ("w") 6 in, S-Sections ("c") 6 in, T-Sections ("w")	3'-0" 2'-6" 3'-0"

- K. Erect studs one piece full length. Splicing of studs is not permitted, except where detailed.
 - 1. Where studs have been cut to receive piping conduits and equipment, weld on two 3/4 inch furring channels to restore stability of weakened stud unless noted otherwise on the drawings.
- L. Erect studs, brace and reinforce full strength to meet design requirements.

- M. Extend stud framing through ceiling to underside of floor or roof structure above unless detailed otherwise.
- N. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- O. Install intermediate studs above and below openings to match wall stud spacing.
- P. Provide deflection allowance of 1/2 inch minimum in stud track, directly below horizontal building framing for non-load bearing framing.
- Q. Attach backing as detailed on the drawings for attachment of fixtures anchored to walls.
 - 1. Where Casework is anchored as part of a larger wall or panel: Refer to Section 06 41 16.
- R. Install framing between studs for attachment of mechanical and electrical items and to prevent stud rotation.
- S. Touch-up field welds and damaged primed surfaces with primer.
- T. Erect 2 stud construction at expansion joints, 20 feet on center or as indicated on Drawings.
- 3.03 CEILING JOIST FRAMING
 - A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with enlarged service holes, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness:
 - a. 20 GA (0.0329 inch) (0.84 mm).
 - b. 18 GA (0.0428 inch) (1.09 mm).
 - c. 16 GA (0.0538 inch) (1.37 mm).
 - d. 14 GA (0.0677 inch) (1.72 mm).
 - e. 12 GA (0.0966 inch) (2.45 mm).
 - 2. Flange Width: 1-5/8 inches (41 mm), minimum unless noted otherwise on structural drawings.
 - 3. Install per drawings and conform to SSMA.

3.04 TOLERANCES

- A. Maximum Variation from True Position: 1/8 inch in 10 feet.
- B. Maximum Variation of any Member from Plane: 1/8 inch.
- 3.05 CLEANING
 - A. Clean substrate; remove dirt, oil, grease, construction markings, and foreign matter that could adversely affect final floor finish appearance or performance.

3.06 QUALITY CONTROL

A. Inspection of all field-welding operations shall be performed by qualified and certified Welding Inspector approved by the Structural Engineer and DSA.

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B. Welding Inspector shall check materials, equipment, procedures, welds and certification of welders. Furnish the Owner with reports verified by the Inspector that welding has been performed in accordance with the Contract Documents.

END OF SECTION 054000

SECTION 06 41 16

CASEWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Fabricated base cabinet units.
 - 2. Fabricated wall units.
 - 3. Fabricated countertops.
- B. Related Sections
 - 1. Section 11 53 14 Laboratory Work Surfaces.
 - 2. Refer to drawings for Finish Schedule
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ADA Americans with Disabilities Act of 1990, as amended
 - 1. ADA Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design.
 - C. CBC 2016 California Building Code
 - 1. CBC Chapter 11B, Accessibility to Public Buildings, Public Accommodations, Commercial Facilities and Publicly Funded Housing
 - 2. CBC Chapter 16A, Structural Requirements
 - D. ASCE/SEI 7-10 American Society of Civil Engineers, Structural Engineers Institute, ASCE Standard.
 - E. NEMA LD 3 High Pressure Decorative Laminates: National Electrical Manufacturers Association, 2005 Edition.
 - F. DOC PS 20 American Softwood Lumber Standard.
 - G. DOC PS 1-07 Department of Commerce Product Standard, U.S. Product Standard for Construction and Industrial Plywood.
 - H. WI Woodwork Institute, Architectural Woodwork Standards (AWS), Latest Edition.
 - I. ANSI A208.1 Particleboard.
 - J. ANSI A208.2 Medium-Density Fiberboard-2009.
 - K. ANSI/HPVA HP-1 American National Standards for Hardwood and Decorative Plywood.
- L. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- M. California Title 17 Division 3 Subchapter 7.5 Air Bourne Toxic Control Measures, Section 93120.1 through 93120.12.
- N. SCAQMD South Coast Air Quality Management District Regulations Rule 1168 Adhesive and Sealant Applications
- 1.03 SUBMITTALS
 - A. Action/Informational
 - 1. Shop drawings including materials, component profiles, fastening methods, assembly methods, joint details, accessory listings and schedule of finishes.
 - 2. Product data.
 - B. Record
 - 1. Statement of qualification from fabricator.
 - 2. WI Certifications.
- 1.04 QUALITY ASSURANCE
 - A. Cabinets and countertops shall be manufactured in accordance with Sections 10, 11 and Supplements of the latest edition of the Architectural Woodwork Standards of the Woodwork Institute for Grade specified herein or to higher standards as specified herein.
 - B. Fabricator Qualifications: A firm experienced in producing architectural woodwork similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. Company specializing in manufacturing the products specified in this section with minimum five years documented experience. Cabinet manufacturer shall be a WI Licensed Fabricator and active member of the Woodwork Institute.
 - 1. Installer shall be WI Certified.
 - C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production and installation of interior architectural woodwork with sequence-matched wood veneers including wood doors where veneer matching includes door faces.
 - D. Before delivery to the jobsite, the casework supplier shall submit a WI Certified Compliance Certificate (Certified Compliance Program) indicating the products furnished for this job, and certifying that they will fully meet all the requirements of the grade or grades specified.
 - E. Each elevation of casework and countertop shall bear a Certified Compliance Label.
 - F. First page of shop drawings shall bear the WI Certified Compliance Label. Shop drawings not conforming to this requirement will be rejected.

- G. Statement shall appear prominently on the shop drawings certifying that all casework construction complies to the structural requirements of to ASCE 7-10, Section 13.5 Table 13.5-1 for required horizontal force factor for anchorage of non-structural components.
- H. One (1) copy of the latest issue of the WI AWS shall be made available for reference at the jobsite throughout the installation period.
- I. Inspections by Authorized WI inspectors shall be made in accordance with the following schedule:
 - 1. Shop inspection at place of manufacturer, prior to initial shipment of cabinet components to site.
 - 2. Site inspection immediately following installation of first cabinet components.
 - 3. Site inspection immediately following final installation of all cabinet Work.
 - 4. Additional site inspections may be required at the option of the Architect and at no cost to the Owner when certified WI inspection reports indicate unsatisfactory conformance with specified requirements.
 - 5. Provide full written reports to Architect.
- J. Written confirmation of all WI inspections shall be submitted, including a WI Certified Compliance Certificate for installation.
- K. WI Certification costs shall be included.
- L. Pre-installation Conference
 - 1. Convene two weeks prior to commencing work of this section.
- M. Regulatory Requirements: Formaldehyde limits.
 - Hardwood plywood, particleboard, and medium density fiberboard composite wood products used on the interior or exterior of the building shall meet the requirements for formaldehyde as specified in ARB's Air Toxic Control Measure (ATCM) for Composite Wood (17 CCR 93120 et seq.). Those materials not exempt by the ATCM must meet the specified emission limits, as shown in Table 5.504.4.5.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials only when the project is ready for installation and a clean storage has been provided in accordance with the WI Manual of Millwork.
- 1.06 FIELD MEASUREMENTS
 - A. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.07 COORDINATION

- A. Coordinate the work with electrical rough-in and floor finish sections.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

1.08 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and will maintaining temperature between 60 and 90 deg F and relative humidity between 17 and 50 percent during the remainder of the construction period as recommended by AWS for the location of the project.

1.09 WARRANTY

- A. The manufacture shall warrant products from delamination, loose edges, defective or broken hardware, broken casters, loose wood trim, and horizontal or vertical members coming apart from each other and in general against defects in materials and workmanship for 5 years after Substantial Completion.
- B. The manufacturer further agrees after delivery date, to repair or replace without charge any woodwork that is defective within the meaning of this warranty. The manufacturer agrees to pay charges for finishing or installing replaced woodwork. This Warranty is not effective if goods are repaired or replaced without first obtaining the manufacturer's written consent.

PART 2 - PRODUCTS

- 2.01 REGULATORY REQUIREMENTS
 - A. Operable parts for all accessible casework shall comply with CBC Section 11B-309.
- 2.02 ACCEPTABLE MANUFACTURERS
 - A. Products of the following laminate materials manufacturers form the basis for design and quality intended.
 - 1. Formica Corporation, Cincinnati, OH.
 - 2. Wilsonart International, Temple, TX.
 - 3. ABET Inc., Inglewood, NJ.
 - 4. Nevamar Corporation, Odenton, MD.
 - 5. Pionite Decorative Laminates, Maumee, IL.

6. Or equal as approved in accordance with Division 01, General Requirements for Substitutions.

2.03 GRADES

- A. Provide plastic covered casework in accordance with WI AWS, Section 10 for Custom Grade. ASTM E84, Class B, Flame Spread: Less than 75, Smoke Developed: less than 100.
- B. Construction Style: Style A frameless.
- C. Construction Type: Type I multiple self-supporting units rigidly joined together.
- D. Door and Drawer Front Style: Flush overlay.
- 2.04 CASEWORK UNITS
 - A. Casework indicated on drawings shall conform to model Series described below:
 - 1. Base Cabinets: 100 Series.
 - 2. Drawer Base Cabinets: 200 Series.
 - 3. Wall Hung Cabinets: 300 Series.
- 2.05 LAMINATE MATERIALS
 - A. Plastic Laminate Cabinet Surfaces: NEMA LD 3, ASTM E84, Class B, Decorative High Pressure Laminate, General Purpose type, 0.028 inch thick at vertical surfaces (VGS), 0.050 inch thick at horizontal surfaces (HGS) and 0.042 inch thick (HGP) for post-formed work. Colors as selected, in wood grains, patterns or solids. Conform to Section 10, WI AWS.
 - B. Plastic Laminate Countertops: NEMA LD 3, ASTM E84, Class B, Decorative High Pressure Laminate, General Purpose type, 0.042 inch thick (HGP) when post-formed, 0.050 inch thick (HGS) when flat. Colors as selected in wood grains, patterns or solids. Conform to Section 11, WI AWS.
 - C. Laminate Backing Sheet: NEMA LD 3, High-pressure decorative laminate, BKV Backing Grade, non-decorated high-pressure plastic laminate, with face material of 0.028 inch.
 - D. Cabinet Liner CLS for cabinet interiors: NEMA LD 3, CLS grade 0.020 inch thick, high pressure decorative laminate.
 - E. Semi-exposed Areas of Cabinets: High-pressure laminate Cabinet Liner CLS, except as specified herein.
 - 1. Apply Decorative High Pressure Laminate, General Purpose, to all surfaces visible from a seated or standing position, including interior surfaces of open casework, shelving, and casework with glass doors, to sloped tops and to tops up to 72 inches above floor or visible from an upper level.
 - 2. Apply Decorative High Pressure Laminate, General Purpose, to shelving, horizontal surfaces and all surfaces behind markerboards.

- F. Refer to Section 09 06 00 Schedules for Finishes
 - 1. Multiple plastic laminate colors at various horizontal and vertical surfaces as selected by Architect.
- 2.06 EPOXY RESIN COUNTERTOPS
 - A. Per Section 11 53 14 Laboratory Work Surfaces.
- 2.07 WOOD MATERIALS
 - A. Softwood Lumber: PS 20; Graded in accordance with WI Custom Grade, Douglas Fir, Hemlock, Ponderosa Pine or Sugar Pine.
- 2.08 CORE MATERIALS
 - A. Core, the following:
 - 1. Wood Particleboard: ANSI A208.1, Table A, Grade M-2, 47 lbs/cu.ft. Medium Density Grade, made with water-resistant binder, no added urea formaldehyde permitted, Title 17 CCR.
 - 2. Medium Density Fiberboard: ANSI A208.2,
 - a. Grade 155 MR30: Medite II, no formaldehyde added, 100 percent pre-consumer recycled wood. Title 17 CCR by SierraPine.

2.09 ACCESSORIES

- A. Contact Adhesives: In accordance with Woodwork Institute for Type II rating, AWS, and specifically approved by WI for the area in which the Project is located. Wilsonart WA H2O, water-based contact adhesive, or equal.
 - 1. Adhesives applied on-site shall comply with VOC content limits defined by SCAQMD Rule 1168.
- B. Fasteners: Size and type to suit application.
- C. Bolts, Nuts, Washers, Lags, Pins and Screws: Of size and type to suit application.
- D. Support angle brackets for countertops: 18" brackets, steel angle 1/4" thick, 2" legs, mitered and welded, ground smooth, unless noted otherwise on drawings, install at 16" on center. Finish: baked enamel, off white.
- E. Doorstop Blocks: Nylon type, 1 inch x 1 inch x 2 inches long.
- F. Cable Grommets: Molded-plastic grommets 3 inch diameter and matching plastic caps with slot for wire passage, Hafele 429.99, color: black .
- G. Edge Banding: High Pressure Plastic Laminate, Premium Grade at countertop edges and at cabinet door, drawer and shelf edges. Color to match cabinet faces.
- H. Edge Banding for drawer and shelf edges: Premium Grade PVC 3 mm edge banding; at drawers of width to match component thickness, straight edge (no radius). Color as selected by Architect.

- I. Countertop Brackets: Surface-mounted Brackets EH Series EH-1824for up to 24 inches deep counter, manufactured by Rakks Store, Needham, MA or equal. Refer to Drawings for sizes.
- J. Wire Management: Mockett WM22A; Description: J-Shape, wire manager with flange fastened under a desk/work surface to route cables. Size: 4-5/16" H x 1-3/32" D x 2-9/16" high trough. Color: Matte black.

2.10 HARDWARE

- A. Conform to WI Architectural Woodwork Standards (AWS) and CBC Sections 11B-309 and 11B-225. Any hardware listed therein may be installed, except where those standards are exceeded as described below: "or equals" as substitutions may be submitted in accordance with Division 01 General Requirements.
 - 1. Drawer Slides: Minimum 100 lb. capacity all drawers. Full extension ball bearing type only, Accuride 3832 Classic for 16 in. wide or less, 7432 full extension 100 lbs rated, ball bearing, for drawers 24 in. wide or less and 3640A full extension 200 lbs rated, for 42 in. wide or less.
 - 2. Drawer Slides-Lateral files: Minimum 200 lb. capacity all drawers. Full extension ball bearing type only, Accuride 3640A
 - 3. Wall Cabinet Shelf Standards and Clips:
 - a. Flush type Brackets: KV#255BR steel:
 - 1) Closed shelves Clips: KV #256 clips.
 - 2) Open shelves Clips: KV#243ZC, let-in and screwed in place, for seismic restraint.
 - 4. Hinges: Sizes: to fit door and panel thickness.
 - a. Institutional heavy-duty Concealed, 3D Clip-On, ANSI/BHMA 156.9 Grade 1, 3/16 inch steel, Aximat 300 and 200 Single Pivot, by Hafele America Co. Use Twin overlay hinge 334.06.902 where applicable. Matte nickel finish.
 - 5. Wire Pulls: "U-shaped", Trimco/BBW No. 562-4, 4 inch satin stainless steel, P2 Series by Terry Hinge.
 - 6. Locks: 6 pin cylinders:
 - a. Schlage CL100 all door locks and CL200 all drawer locks, Schlage "C" keyway, 6-pin.
 - 7. Elbow Catches: EPCO 1018 nickel at inactive cabinet door leaf.
 - 8. Magnetic Catches: EPCO 591, all cabinet doors, 5 pound holding strength.
 - 9. Coat Hooks: wall mounted, single; Ives IV581AM. Double: Ives IV582AM, Rockwood or equal. Mount at 44 inches maximum height AFF.
 - 10. Sliding Door Pulls: Wire Pulls, "U" shaped, Trimco/BBW No. 562-4, 4 inch, stainless steel.
- B. Finish: US-26D, Dull Chrome (Satin Chromium), unless noted otherwise.
- 2.11 FABRICATION
 - A. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings.

- B. When necessary to cut and fit on site, provide materials with ample allowance for cutting.
- C. Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Make corners and joints hairline. Locate counter butt joints minimum 2 feet from sink cutouts. All patterns to run in the same direction.
- D. Install one door stop block screwed on the inside bottom of the inactive leaf to prevent the door from being pushed down to gain entry at all double doors base cabinets. Secure with 2 screws 1-1/2 long at each block.
- E. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Verify locations of cutouts from on-site dimensions. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs. Seal contact surfaces of cut edges.
- F. Provide access panels where required to access plumbing and associated casework utilities.
- G. Countertop Backsplash: unless otherwise noted on drawings. Backsplash tops: square with scribe.
- H. High Pressure Plastic Laminate Countertop Edges:
 - 1. Square edge: Self-edge Laminate shall be applied first with top laminate extending over the edge laminate in same method as Premium Grade. Eased exposed edges. Adhere with hot-melt adhesive.
- I. Edge Banding: High Pressure Laminate with hot melt adhesive applied, prime before application of adhesive, at cabinet doors, drawers, shelves.
- J. Edge Banding: Premium Grade PVC 3 mm at drawer and shelf edges.
- K. Shelf Loading: 50 lbs. per square foot or 50 lbs. per cubic foot of total volume of cabinet whichever is less. In no case shall unsupported shelf exceed 36" wide without mid support. Conform to Table 1607A.1, California Building Code.
- L. Shelf Thickness: 1 inch. All shelf surfaces and edges shall be finished with High Pressure Decorative Laminate PVC 3 mm edge with hot melt adhesive.
- M. Install one grommet per workstation or at every 48 inches of work counter.

PART 3 - EXECUTION

- 3.01 PREPARATION
 - A. Verify adequacy of backing and support framing.
 - B. Layout markings shall not be made with xylene-based inks, paint, or dyes, or with other solvent-based products that may bleed through finishes.

3.02 INSTALLATION

- A. Set and secure casework in strict accordance with the WI AWS.
- B. Set shelves on specified clips, secure with wood screws each clip, front only. Confirm shelves spacing with Owner, do not proceed without Owner's approval.
- C. Casework shall be anchored to walls or floors or both. Conform to ASCE 7-10, Section 13.5 Table 13.5-1 anchorage requirements.
 - 1. Where casework is anchored on 16 gauge steel studs as part of the larger wall or panel: Use 16 gauge steel studs throughout and continuous between perpendicular intersections. Refer to Section 05 40 00.
- D. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Align adjacent countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
- E. Countertop Brackets: Install to support counters that would be supporting computers at maximum spacing of 48 inches on centers.
- 3.03 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, hardware, fittings and fixtures.

END OF SECTION

SECTION 07 01 52

ROOFING MEMBRANE PENETRATIONS

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Coordination of roof membrane penetrations with affected trades.
 - B. Establishment of criteria for penetrating roof membranes either before or after installation of membranes when penetrations are required by the Work of other Sections.
 - C. Related Sections
 - 1. Section 07 62 00 Sheet Metal Flashing and Trim.
 - 2. Section 07 92 00 Joint Sealers.
 - 3. Division 23 Heating Ventilation and Air Conditioning.
 - 4. Division 26 Electrical.
 - 5. Other Sections of the Specifications requiring penetrations.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. Sheet Metal and Air Conditioning Contractors' National Association, SMACNA, "Architectural Sheet Metal Manual," Sixth Edition.
- 1.03 QUALITY ASSURANCE
 - A. Qualifications: Use only skilled workmen who are thoroughly trained and experienced in the necessary crafts.

1.04 WARRANTY

- A. For existing work, Contractor shall verify if any warranty is in effect and maintain that warranty for all new penetrations. Written certification from the roofing manufacturer of the existing roofing indicating that the membrane penetrations as installed and sealed meet the or exceed the requirements to maintain the existing roofing warranty.
- PART 2 PRODUCTS
- 2.01 MATERIALS
 - A. Existing materials shall match existing roofing system previously installed.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the substrates and conditions under which Work of this Section will be performed. Do not proceed until unsatisfactory conditions detrimental to timely and proper completion of the Work have been corrected.
- 3.02 PREPARATION
 - A. Protect membranes, flashing and adjoining surfaces from damage.
- 3.03 INSTALLATION
 - A. Group or cluster pipe and conduit in common penetrations wherever possible to minimize the number of penetrations through membrane.
 - B. Permitted clearances, except as specifically detailed:
 - 1. Between penetrations for single pipes: 20 inches clear.
 - 2. Between penetration for single pipe and toe of cant strip at curb or parapet: 18 inches clear.
 - 3. Between toes of cant strips at curbs or parapets: 18 inches clear.
 - C. Make penetrations in a manner consistent with membrane and flashing installations as follows:
 - 1. As detailed and specified is Section 07 62 00.
 - 2. Where not detailed or specified meet recommendations of Referenced Standards as follows.
 - a. SMACNA Figure 4-13 thru 4-16.
 - b. NRCA BUR/MB-12, 13, and 17,18, 19, 21, 22, 23, Single Ply TP-11, 12, 16, 17, 18, 20, 20B, 20C, 22.
 - c. Meet requirements of Section 07 92 00 for sealants and priming.
 - 3. Where not addressed by details, Specifications or referenced standards, request direction of Architect.

END OF SECTION

SECTION 07 21 00

INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Thermal insulation in exterior wall and roof construction.
- B. Sound attenuation insulation in interior partition construction.
- C. Related Requirements:
 - 1. Energy calculations or prescriptive compliance documents.

1.02 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. ASTM American Society for Testing and Materials
 - 1. ASTM C 165 Test Method for Measuring Compressive Properties of Thermal Insulations
 - 2. ASTM C 356 Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat
 - 3. ASTM C 612 Mineral Fiber Block and Board Thermal Insulation
 - 4. ASTM C 665 Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
 - 5. ASTM C 1104 Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation
 - 6. ASTM C 1304 Test Method for Assessing the Odor Emission of Thermal Insulation Materials
 - 7. ASTM C 1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings
 - 8. ASTM D 816 Rubber Cements
 - 9. ASTM E 84 Surface Burning Characteristics of Building Materials
 - 10. ASTM E 96 Test Methods for Water Vapor Transmission of Materials
 - 11. ASTM E 136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.
- C. CBC 2016 California Building Code
 - 1. CBC-7 CBC Chapter 7, Fire and Smoke Protection Features.
 - 2. Section 120, in conformance with ASTM E-84 or UL 723-Standard for Test for Surface Burning Characteristics of Building Materials.
- D. 2016 California Energy Code, Title 24, Part 6, Subchapter 3, Section 140.3.
- E. SCAQMD South Coast Air Quality Management District Regulations Rule 1168 Adhesive and Sealant Applications.

1.03 PERFORMANCE REQUIREMENTS

- A. Materials shall provide continuity of thermal barrier at building enclosure elements.
- B. Materials shall provide continuity of sound barrier at designated room enclosure elements.
- C. Materials shall conform to Section 720 Thermal and Sound Insulating Requirements, California Building Code and Section 110.8 California Energy Code.
- D. Thermal Resistance: R values to achieve overall assembly U-Factor no greater than applicable value in Table 140.3-B California Energy Code unless noted otherwise in T-24 Energy Report.
- 1.04 SUBMITTALS
 - A. Product Data: Provide data on product characteristics, performance criteria and methods of installation.
 - B. Three samples of each material specified minimum 12 inches square. Provide fasteners, clips and other accessories.
 - C. Certification of Compliance with Section 110.8(a) California Energy Code, 2016 and Part 12, Title 24,CCR Standards for Insulating Materials Chapter 12-13, Section 12-13-1555.
- 1.05 QUALITY ASSURANCE
 - A. Provide U-value limits in accordance with Section 140.3, Table 140.3-B of 2016 California Energy Code, Title 24 Part 6 California Code of Regulations.
 - B. Adhesives shall comply with VOC content limits defined by SCAQMD Rule 1168.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products of following manufacturers form basis for design and quality intended.
 - 1. Johns Manville Insulations, Commercial/Industrial Division, Denver, CO.
 - 2. Certainteed Corporation, Valley Forge, PA.
 - 3. Owens Corning, Toledo, OH.
 - 4. Thermafiber Division of USG Corp., Wabash, IN.
- B. Or equal as approved in accordance with Division 01, General Requirements for Substitutions.

2.02 MATERIALS - THERMAL

- A. Batt Insulation: ASTM C665, Type III, Class A, Category 1. Preformed, foil faced, formaldehyde-free glass fiber batt insulation, with tabs, Johns Manville FSK-25, or equal. Conforming to following:
 - 1. Thermal Resistance: R values to achieve overall assembly U-Factor no greater than applicable value in Table 140.3-B CEC unless noted otherwise in T-24 Energy Report. Minimum R-19.
 - 2. Batt Size: As required to fully fill cavity width and height or length.
 - 3. Thickness: As required to meet specified R-value without compression.
 - 4. Facing: Faced on one side with flame resistant foil facing.
 - 5. Flame Spread: Less than 25, ASTM E 84.
 - 6. Smoke Developed Rating: Maximum 50, ASTM E 84.
 - 7. Permeance: 0.05 perms, ASTM E 96.
 - 8. Recycled Content: Minimum 30 percent.

2.03 MATERIALS - SOUND

- A. Sound Attenuation Insulation: ASTM C665, Type I; preformed glass fiber, formaldehyde-free, "Sound Control Batts", acoustical fiber glass insulation, by Johns Manville or equal. Conforming to the following:
 - 1. Size: As required to fully fill cavity width and height.
 - 2. Thickness: 3-5/8" for 4" walls and 6-1/2" for 6" walls, minimum. 10" thick between floors.
 - 3. Facing: Unfaced.
 - 4. Flame Spread: Less than 25, ASTM E84.
 - 5. Smoke Developed Rating: Maximum 50.
 - 6. Formaldehyde-free.
 - 7. Recycled Content: Minimum 30 percent.
- 2.04 ACCESSORIES
 - A. Fasteners, type and size to suit application.
 - B. Tape: Acrylic with Polypropylene backing, Class A, flame spread less than 25, adhering type, 2-1/2 inch wide; No. 8086 CONTRACTOR SHEATHING TAPE, manufactured by 3m Company, St. Paul, MN, or equal as approved in accordance with Division 01, General Requirements for substitutions.
 - C. Insulation Fasteners: Steel impale spindle and clinch shield on flat metal base with applied adhesive, length to suit insulation thickness, capable of securely and rigidly fastening insulation in place; INSUL-ANCHORS, manufactured by Gemco, Dansville, OH, or equal as approved in accordance with Division 01, General Requirements for substitutions. Self-adhesive base plates are prohibited.
 - D. Adhesive: Tuff Bond Hanger Adhesive manufactured by Gemco, Dansville, OH, or equal as approved in accordance with Division 01, General Requirements for Substitutions.

- E. String wire: Minimum 16 gauge galvanized annealed steel wire spaced at 18" on center.
- F. Do not use salvage cut-offs, materials less than space width, or in multiple short lengths to fill-in the gaps.
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Verify site conditions.
 - B. Verify that substrate and adjacent materials are satisfactorily installed and in place and are ready to receive insulation.
- 3.02 INSTALLATION
 - A. Install insulation in accordance with insulation manufacturer's instructions.1. Clean tracks prior to installation.
 - B. Install in cavities designated to receive sound thermal insulation without gaps or voids. Extend material full height of cavity.
 - C. Cut insulation to fit tightly at cavities between studs not standard 16 inches on center spacing.
 - D. Trim insulation neatly to fit spaces.
 - E. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation. Leave no gaps or voids.
 - F. Extend thermal materials full height of cavity to structure above and as otherwise required to produce a completely insulated building envelope.
 - G. Extend sound materials full height of cavity to structure above and as otherwise required to produce a completely sound insulated enclosure.
 - H. Tape and seal [butt ends, lapped flanges, and] tears or cuts in foil in thermal batts.
 - I. Friction fit semi-rigid sound insulation batts in cavities, no gaps voids permitted.
 - J. Metal Framing: Place foil side of thermal batts toward inside of building. Place insulation fasteners at 36 inches on centers, vertically in two rows at each stud cavity. Tape and seal tears or cuts in foil.
 - Batts Under Metal Roof Decks: Install foil-faced flanged-type insulation batts secured with spindle anchors. Staple flanges together at maximum 4" centers and seal joints at abutting vertical surfaces with a pressure-sensitive plastic tape. Provide 16 gauge galvanized string wires under batts wherever necessary to prevent sagging, stretched taut.

- K. Install material to preclude slipping from place by use of nails, screws, wires or other approved fastening devices.
- L. At roof insulation, provide minimum of 1 inch air space between insulation and roof sheathing.
- M. Where tight, congested, difficult or otherwise unforeseen conditions are encountered, employ alternate application methods or materials to effect the intended insulation system. Alternate methods or materials shall be submitted to Architect for review and approval.
- 3.03 INSPECTION
 - A. Notify Project Inspector before Work is covered. Approval by Project Inspector shall be received before any Work is concealed. Work that has been covered prior to inspection and approval shall be uncovered for inspection and recovered.

END OF SECTION

SECTION 07 26 16

VAPOR BARRIER

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Installation of Vapor Barrier under concrete slabs.
 - B. Related Sections
 - 1. Section 03 30 00, Concrete.
 - 2. Refer to drawings for finish schedule.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. AQMD Local Air Quality Management District Regulations
 - C. ASTM D 882 Tensile Properties of Thin Plastic Sheeting.
 - D. ASTM D 1709 Impact Resistance of Plastic Film by the Free-Falling Dart Method.
 - E. ASTM D 4833 Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
 - F. ASTM E 96 Water Vapor Transmission of Materials.
 - G. ASTM E 154 Water Vapor Retarders Used in Contact with Earth under Concrete Slabs, on Walls, or as Ground Cover.
 - H. ASTM F 1249 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
 - I. ASTM E 1643 Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
 - J. ASTM E 1745 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
- 1.03 SUBMITTALS
 - A. Product Data: For membrane materials and accessories.
 - B. Manufacturer's Installation Instructions.

1.04 QUALITY ASSURANCE

- A. Membrane Manufacturer: Company specializing in high strength density polyethylene use as vapor barrier with five years minimum experience.
- B. Applicator: Company specializing in application of specified vapor barrier with three years minimum experience and approved by manufacturer.
- C. Field Sample
 - 1. Approved sample may be incorporated as part of Work.
- D. Manufacturer Review
 - 1. Contact vapor barrier manufacturer for pre-construction meeting and/or to coordinate a review of the vapor barrier installation either by digital review or in person.
- 1.05 ENVIRONMENTAL REQUIREMENTS
 - A. Do not apply vapor barrier membrane when air temperature is below 50 degrees F.
- 1.06 WARRANTY
 - A. Provide manufacturer's limited 1 year warranty.
 - B. Warranty: Include coverage of materials and installation and resultant damage from failure of installation to resist penetration of moisture.
 - C. Warranty: Include coverage of waterproofing failure to resist penetration of water except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered as structural failure.
 - D. Be responsible for removal and replacement of materials concealing waterproofing.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products of following manufacturers form basis for design and quality intended.
 - 1. Stego Industries LLC, San Juan Capistrano, CA; Product: 15 Mil Stego Wrap.
 - 2. W.R. Meadows, Pomona, CA.; Product: Perminator 15 Mil
 - 3. Reef Industries, Inc. Houston, TX. Product: Vaporguard.
- B. Or equal as approved in accordance with Division 01, General Requirements for substitutions.
- 2.02 MATERIAL
 - A. Physical Properties:1. Puncture Resistant Results ASTM D1709

2266 grams, min.

- 2. Water Vapor
- 3. Transmission Rate ASTM F 1249 0.0036 WVTR
- 4. Permeance (New Material) ASTM F 1249 0.0086 perms
- 5. Permeance
- 6. (After Conditioning
- 7. Tests per Section 7.1) ASTM E 1745 Less than 0.010 perms
- Tensile Strength
 Performance Class
 ASTM E 1745
 ASTM E 1745
 Class A

2.03 ACCESSORIES

- A. Seam Tape
 - 1. Tape must have the following qualities:
 - a. Water Vapor Transmission Rate ASTM E 96 0.03 perms or lower
 - As approved by the vapor barrier manufacturer.
- B. Proofing Mastic

b.

- 1. Mastic must have the following qualities:
 - a. Water Vapor Transmission Rate ASTM E 96 0.17 perms or lower
 - b. As approved by the vapor barrier manufacturer.
- C. Perimeter/Terminating Edge Seal (Choose one of the following)
 - 1. Seal edge of vapor barrier to existing foundation wall or grade beam using double-sided adhesive strip with the following qualities:
 - a. Water Vapor Transmission Rate ASTM E 96 0.03 perms or lower
 - b. As approved by the vapor barrier manufacturer
 - 2. Seal edge of vapor barrier to fresh concrete of slab using a tape with a textured surface that creates a mechanical seal to freshly-placed concrete with the following qualities:
 - a. Water Vapor Transmission Rate ASTM E 96 0.03 perms or lower
 - b. 180° Adhesion Peel Strength: ASTM D 903 17.6 lbf/in
 - c. As approved by the vapor barrier manufacturer
- D. Pipe Boots
 - 1. Construct pipe boots from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer's instructions.
- E. Joint and Crack Sealant: As recommended by manufacturer.

PART 3 - EXECUTION

- 3.01 INSPECTION
 - A. For application under concrete slabs verify with Section 03 30 00 that substrate conditions are ready to receive membrane
 - B. Verify items that penetrate surfaces to receive waterproofing are securely installed and cleaned.
 - C. Beginning of installation means acceptance of substrate.

3.02 PREPARATION

- A. Clean and prepare surfaces to receive vapor barrier in accordance with manufacturer's instructions and ASTM E 1643.
- B. Mask and protect adjacent surfaces not designated to receive waterproofing.
- C. Vacuum surfaces and dispose of removed material.
- 3.03 APPLICATION
 - A. Apply and seal vapor barrier under concrete slab in accordance with manufacturer's recommended procedures and ASTM E 1643.
 - B. For interior forming and screeding applications, do not use non-permanent stakes driven through the vapor barrier. Install forming and screeding devices per manufacturer's standard.
- 3.04 FIELD QUALITY CONTROL
 - A. On completion of membrane installation, apply calcium chloride tests in locations not to exceed 1000 square feet.
 - B. Provide written certification that calcium chloride tests indicate less than 3 pounds per 1000 square feet in tested locations.
- 3.05 PROTECTION
 - A. Close off area to prevent unauthorized traffic or work over membrane.

END OF SECTION

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Roof flashings.
 - 2. Flashings for electrical conduits, mechanical lines and plumbing water lines roof penetrations.
 - 3. Equipment support stand penetrations.
- B. Related Section:
 - 1. Section 09 90 00, Painting.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. California Building Code 2016 Chapters 14 and 15.
 - C. American Society for Testing and Materials (ASTM)
 - 1. ASTM A480 General Requirements for Flat-Rolled Stainless Steel and Heat Resisting Steel Plate, Sheet, and Strip.
 - 2. ASTM A653 Sheet Steel, Zinc-Coated (Galvanized) or Zinc Iron Alloy Coated by the Hot-Dip Process
 - 3. ASTM B32 Solder Metal
 - 4. ASTM B209 Aluminum and Aluminum-Alloy Sheet and Plate.
 - 5. ASTM B749 Lead and Lead Alloy Strip, Sheet and Plate Products
 - 6. ASTM D4601 Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
 - D. National Roofing Contractors Association (NRCA)
 - 1. NRCA Manual Fifth Edition.
 - E. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 1. SMACNA Manual Architectural Sheet Metal Manual, Current Edition
- 1.03 SUBMITTALS
 - A. Shop drawings showing material profile, jointing pattern, jointing details, fastening methods and installation details.
 - B. Product data.
 - C. Manufacturer's installation instructions.

- D. Samples for each type of sheet metal flashing and trim indicated with field-applied color finishes.
- 1.04 STORAGE AND HANDLING
 - A. Stack preformed and pre-finished material to prevent twisting, bending, or abrasion and to provide ventilation.
 - B. Prevent contact with materials during storage that may cause discoloration, staining or damage.
- PART 2 PRODUCTS
- 2.01 SHEET MATERIALS
 - A. Galvanized Steel: ASTM A653/A653M-02, G90.
 - B. Aluminum: ASTM B209, 3003-H14 or 5052-H34c Alloy.
 - C. Lead Sheet: ASTM B-749, L51121 Grade.
 - D. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
 - 1. As-Milled Finish: Mill.
- 2.02 ACCESSORIES
 - A. Fasteners: round head, galvanized steel with soft neoprene washers at exposed fasteners. Finish exposed fasteners same as flashing metal.
 - B. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 - C. Self-Adhesive Flashing: 40 mils, nominal, thickness composite sheet, fabricated with 8-mil polyethylene film backing and 32-mil rubberized asphalt sheet waterproofing.
 - 1. Acceptable Products: as follows, or equal, approved in accordance with Division 01, General Requirements, for substitutions.
 - a. Perm-A-Barrier sheet by Grace Construction Products, Cambridge, MA
 - b. Carlisle Coatings and Waterproofing CCW-705T-WF
 - c. Henry Company, Blueskin-SA
 - d. FortiFlash 40 Recessed Window Flashing by Fortifiber.
 - 2. Furnish with prefabricated corner pieces, if available from sheet manufacturer. Provide manufacturer's edge and top sealant or mastic, and primers.
 - D. Ice Dam Underlayment: ASTM D 1970, Rubberized asphalt coated polyethylene film, 40 mils thick, Grace Ice & Water Shield HT, High Temperature, by W.R. Grace & Co., Cambridge, MA, or equal as approved in accordance with Division 01 for substitutions.
 - E. Metal Primer: For repair of Galvanized sheet metal, Zinc type, Galvilite by ZRC or equal.

- F. Protective Backing Paint: Bituminous.
- G. Sealant: Two-component, polyurethane-type specified in Section 07 92 00, Joint Sealants.
- H. Solder: ASTM B32; Grade Sn50, flux type and alloy composition as required for use with metals to be soldered. Raw muriatic acid for galvanized steel; rosin for lead; non-corrosive soldering salts for uncoated copper and acid-type flux formulated for soldering stainless steel.
- I. Solder for Stainless Steel: ASTM B 32, Grade Sn60 with acid flux of type recommended by stainless-steel sheet manufacturer.
- J. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- K. Rosin-Sized sheathing paper: Sealtight Red Rosin Paper by W.R. Meadows.
- L. Termination Bar: Mill finished Extruded aluminum (6063 alloy) with radius corners.
- 2.03 FABRICATION
 - A. Form sections true to shape, accurate in size, square and free from distortion or defects. Fabricate all components per SMACNA standards unless more stringent conditions are imposed by the Roofing Contractor, in that case the more stringent conditions shall prevail.
 - B. Fabricate cleats and starter strips of same material as sheet, interlockable with sheet.
 - C. Form pieces in longest practical lengths.
 - D. Hem exposed edges on underside 1/2 inch; miter and seam corners.
 - E. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
 - F. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - G. Solder lap seams of all non-moving metal joints and seal other metal joints, rivet to strengthen seam. After soldering, remove flux. Wipe and wash solder joints clean.
 - H. Fabricate corners from one piece with minimum 18 inch long legs; solder seam for rigidity.
 - I. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.
 - J. Fabricate flashings to allow toe to extend 2 inches over roofing. Return and break edges.

- K. Provide expansion joints for gutters at every 30 feet. Fabricate per SMACNA details.
- L. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.
- 2.04 FINISH
 - A. Galvanized finish: ASTM A653/A653M-02, G90.
 - B. Aluminum finish: As-Milled Finish, One-side bright mill.1. Clear or Color Anodic Finish only where indicated on drawings.
 - C. Shop prepare and prime exposed ferrous metal surfaces.
 - D. Back paint concealed metal surfaces with protective backing paint when in contact with copper, redwood or red cedar.
- PART 3 EXECUTION
- 3.01 INSPECTION
 - A. Verify roof openings, curbs, pipes, sleeves, ducts or vents through roof are solidly set, cant strips and reglets in place and nailing strips located.
 - B. Verify membrane termination and base flashings are in place, sealed and secure.
 - C. Beginning of installation means acceptance of existing conditions.
- 3.02 PREPARATION
 - A. Field measure site conditions prior to fabricating Work.
 - B. Install starter and edge strips and cleats before starting installation.
 - C. Install reglets true to lines and levels. For surface-mounted seal top of reglets with sealant.
 - D. Insert counterflashings into reglets to form tight fit. Seal flashings into reglets with sealant.
 - E. Secure flashings in place using concealed fasteners. Use exposed fasteners only in locations approved by Architect.
 - F. Lock and seal all joints.
 - G. Apply plastic-cement compound between metal flashings and felt flashings.
 - H. Fit flashings tight in place. Make corners square, surfaces true and straight in planes and lines accurate to profiles.
 - I. Seal metal joints watertight.

3.03 INSTALLATION

- A. Roof Flashings: Provide roof flashings as indicated in drawings and required to complete entire project. Submit shop drawings showing details for approval, use minimum of 24 gauge galvanized steel.
- B. Counterflashings for roof hatches and skylights: 24 gauge sheet metal flashing, removable, per NRCA BUR/MB-14.
- C. Roof Pipe Penetrations Flashings: Provide pre-manufactured flashings and counterflashings for pipe penetrations for electrical conduits, mechanical and plumbing lines. Flashing: 4 lb seamless lead reinforced with steel boot, with 6" flange [Stainless Steel, 26 gauge]. Field seal top of cast-iron counterflashing with silicone sealant per Section 07 92 00, secure to pipe with set screw.
 - 1. Model 1100-4 Series by Elmdor/Stoneman, City of Industry, CA: For single pipe penetrations and 1100-5 Series for vents.
 - 2. Model 910 Future Flash and 915 Multi-Flash Adaptors by Elmdor/Stoneman, City of Industry, CA: Multiple-pipe penetrations, within single pre-manufactured flashing unit: Counterflashing: PVC cap, adapter base and compression nut. Compression rings and gasket. Install per manufacturer's instructions.
 - 3. OR
 - 4. Model Alum-Flash Mara-Boot and Pipe Flashing System by Portals Plus, Inc. Bensenville, IL: Aluminum base flange with EPDM compression molded rubber cap and stainless steel snaplock clamp. Use "Plasti-Flash System" for thermoplastic roofs unless flashings specified in Roof Section.
 - 5. Stainless Steel Flashings: SBC Industries, Opa Locka, FL.
- D. Miscellaneous: Provide miscellaneous flashings as indicated in drawings and required to complete entire project, except for items provided under other Sections. Submit shop drawings showing details for approval and use minimum of 24 gauge galvanized steel.
- 3.04 FINISH
 - A. Paint exposed metal flashings with High Performance paints in accordance with Section 09 90 00, for Special Coatings. Colors to be selected by Architect.

END OF SECTION

SECTION 07 84 00

FIRESTOPPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems, products, materials and accessories.
- B. Through-penetration firestopping systems.
- C. Firestopping at intersections of fire-rated partitions and horizontal assemblies.
- D. Perimeter Fire Containment System Safing insulation.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ASTM E84 Surface Burning Characteristics of Building Materials.
 - C. ASTM E814 Fire Tests of Through-Penetration Firestops.
 - D. ASTM E119 Fire Tests of Building Construction and Materials.
 - E. ANSI/UL 2079-98 Tests for Fire Resistance of Building Joint Systems.
 - F. ASTM E1966 Standard Test Method for Fire-Resistive Joint Systems.
 - G. ASTM E2307 Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier System Using Intermediate-Scale, Multi-story Test Apparatus.
 - H. UL Fire Resistance Directory, Latest Edition.
 - I. UL Fire Resistance Directory for Perimeter Fire Containment System per UL XHDG and UL XHGU.
 - J. UL 1479 Fire Tests of Through-Penetration Firestops.
 - K. UL 2079 Tests for Fire Resistance of Building Joint Systems.
 - L. Chapter 7, 2016 California Building Code.
 - M. California Green Building Standards Code, CALGreen 2016.
- 1.03 SUBMITTALS
 - A. Product Data: Provide data on product characteristics, performance and limitation criteria.

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- B. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
 - 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- C. UL approval numbers for firestopping materials, devices and systems.
- D. State approvals for firestopping materials and devices and systems.

1.04 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer: Company specializing in manufacture of products specified in this Section, with minimum five years' experience.
 - 2. Installer Qualifications: A firm that has been approved by either FMG or UL.
 - a. FMG 4991, "Approval of Firestop Contractors."
 - b. UL, "Qualified Firestop Contractor" program.
 - c. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its through-penetration firestop system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Regulatory Requirements
 - 1. Conform to Sections 714, 715 and 720.1, 2016 CBC for fire resistance standards and requirements for penetrations and joint systems in walls, partitions, floor-ceilings and roof-ceilings.
 - 2. Firestop Systems installation shall meet requirements of ASTM E814, UL 1479, or UL 2079 tested assemblies that provide fire rating equal to that of construction being penetrated.
 - 3. Maintain one copy of current UL Fire Resistance Directory Listings, on jobsite at all times.
 - 4. Firestopping systems shall meet temperature limitations as described in ASTM E119 and hose stream exposure as described in ASTM E814.
 - 5. Firestopping system components shall consist of materials exhibiting limited combustibility, and shall have an oxygen index greater than 40 when tested in accordance with ASTM D2863. The flame spread rating shall be a maximum of 20 when tested in accordance with ASTM E84.
 - 6. Firestopping system components shall have low smoke producing characteristics (less than 200) when tested in accordance with ASTM E84.
 - 7. Electrical Boxes shall meet the requirements of UL 514.
 - 8. Firestopping systems are subject to review by the **OSHPD** Fire Life Safety Officer.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply materials when temperature of substrate material and ambient air is below manufacturer's minimum recommendations.
- B. Maintain ambient air temperature above this minimum temperature before, during and for 3 days after installation of materials.
- C. Provide ventilation in areas to receive solvent cured materials.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.
- C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
- D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- E. Do not use damaged or expired materials.
- 1.07 SEQUENCING
 - A. Sequence Work to permit firestopping materials to be installed during or after adjacent and surrounding Work is complete.
- PART 2 PRODUCTS
- 2.01 GENERAL
 - A. Manufacturers, products and systems as listed in UL Fire Resistance Directory, are approved for use under this Section:
 - 1. Through-Penetration Firestop Systems, (XHEZ) Field-Erected Type.
 - 2. Fill, Void or Cavity Materials (XHHW), Installed at Jobsite.
 - 3. Firestop Devices (XHJI), Factory Built Systems.
 - a. For Nonmetallic tubing, conduits, and cables for low voltage applications: Refer to Section 07 84 13.
 - 4. Forming Materials (XHKU) Jobsite Applied.
 - 5. Through-Penetrating Products (XHLY) Cable, Conduit, Pipe and Tubing.
 - 6. Joint Systems (XHBN) showing Class II and Class III movement capabilities.
 - 7. Perimeter Fire Containment Systems per XHDG and XHGU.
 - B. Manufacturers, products and systems as listed in the WHI Certification Listings, are approved for use under this Section:
 - 1. Through-Penetration Firestop Systems: Listed in "Firestop Systems" Section.

- C. Materials and devices utilized in the above referenced systems shall be used only in those systems in which they were tested. Substitutions are not permitted.
- D. Or approved equal systems in compliance and listed in the UL Directory.

2.02 APPROVED FIRESTOPPING SYSTEMS

- A. 3M Inc., St Paul, MN www.3m.com/firestop
 - 1. Sealants, caulking, or spray materials used for openings between structurally separate sections of wall and floors, and top of wall conditions. Following products are acceptable:
 - a. 3M IC 15WB+ intumescent sealant.
 - b. 3M CP25WB+ intumescent sealant.
 - c. 3M FireDam 150+ acrylic latex sealant.
 - d. 3M Fire Barrier Mortar. Firestop Mortar.
 - e. 3M Fire Barrier 3000WT Water Tight Silicone Sealant
 - f. 3M FireDam Spray 200
 - g. Equivalent products listed in the U.L. Fire Resistance Directory Volume 2
 - 2. Sealants, caulking or spray materials for use with fire-rated construction joints, edge of slab perimeter joints, and other gaps. Following products are acceptable:
 - a. 3M FireDam Spray 200
 - b. 3M FireDam 150+ acrylic latex sealant.
 - c. 3M Fire Barrier 1000 NS Silicone Sealant
 - d. 3M Fire Barrier 1003 SL Silicone Sealant
 - e. Equivalent products listed in the U.L. Fire Resistance Directory Volume 2A, 2B.
 - 3. Cast-in place firestop devices for use with noncombustible and combustible pipes (closed and open systems), conduit, and cables bundles penetrating concrete floors, following products are acceptable:
 - a. 3M Fire Barrier Cast-in place MCID firestop device for use with Metallic penetrants
 - 1) Add Aerator adaptor when in used in conjunction with aerator (solvent) system.
 - b. 3M Tub Box Kit for use with tub installations.
 - c. 3M Fire Barrier Cast-in place PCID firestop device for use with noncombustible penetrants.
- B. Hilti Inc., Tulsa, OK.
 - 1. Sealants, caulking, or spray materials used for openings between structurally separate sections of wall and floors, and top of wall conditions. Following products are acceptable:
 - a. Hilti CP 672 Firestop Spray
 - b. Hilti CP 601s Elastomeric Firestop Sealant
 - c. Hilti CP 606 Flexible Firestop Sealant
 - d. Hilti CP 637 Firestop Mortar.
 - e. Equivalent products listed in the U.L. Fire Resistance Directory Volume 2
 - 2. Sealants, caulking or spray materials for use with fire-rated construction joints, edge of slab perimeter joints, and other gaps. Following products are acceptable:
 - a. Hilti CP 672 Firestop Spray
 - b. Hilti CP 601s Elastomeric Firestop Sealant

- c. Hilti CP 606 Flexible Firestop Sealant
- d. Equivalent products listed in the U.L. Fire Resistance Directory Volume 2A, 2B.
- 3. Cast-in place firestop devices for use with noncombustible and combustible pipes (closed and open systems), conduit, and cables bundles penetrating concrete floors, following products are acceptable:
 - a. Hilti CP 680 Cast-in place firestop device.
 - 1) Add Aerator adaptor when in used in conjunction with aerator (solvent) system.
 - b. Hilti CP 681 Tub Box Kit for use with tub installations.
 - c. Hilti CP 682 Cast-in place firestop device for use with noncombustible penetrants.
- 4. Firestop Devices: Factory-assembled steel collars lined with intumescent material sized to fit specific outside diameter of penetrating item, the following products are acceptable:
 - a. Hilti CP 643N Firestop Collar
- 5. Fire Rated Cable Pathways: Hilti Speed Sleeve Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
 - a. Hilti CP 653 Speed Sleeve
- 6. Firestop Drop-In-Device: Hilti Drop-In-Device Brand devices used with noncombustible and combustible pipes (closed and open systems), penetrating concrete floors, the following products are acceptable:
 - a. Hilti CFS DID (Drop-In-Device)
- 7. Wall Opening Protective Materials: Intumescent, non-curing pads or inserts for protection of electrical switch and receptacle boxes to reduce horizontal separation to less than 24", the following products are acceptable:
 - a. Hilti Firestop Box Inserts
 - b. Hilti CP 617 Puddy Pads
- 8. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
 - a. Hilti CP 618 Puddy Stick
- 9. Wrap Strips: Single component intumescent elastomeric strips faced on both sides with a plastic film, the following products are acceptable:
 - a. Hilti CP 648S Firestop Wrap Strip
 - b. Hilti CP 648E Firestop Wrap Strip
- 10. Firestop Block: Re-enterable, non-curing, intumescent flexible 2 component polyurethane foam block, the following products are acceptable:
 - a. Hilti CP657 Fire Block
- 11. Mortar: Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar, the following products are acceptable:
 - a. Hilti CP 637 Firestop Mortar
- 12. Silicone Foam: Multicomponent, silicone-based liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam, the following products are acceptable:
 - a. Hilti CP 620 Fire Foam
- 13. Composite Sheet: Intumescent material sandwiched between a galvanized steel sheet and steel wire mesh protected with aluminum foil, the following products are acceptable:

- a. Hilti CP 675T Firestop Board
- 14. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material for use in blank openings and cable sleeves, the following products are acceptable:
 - a. Hilti CP 658T Firestop Plug
- C. Specified Technologies, Inc., Somerville, NJ.
 - 1. Latex Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
 - a. SpecSeal Series SSS Intumescent Sealant
 - b. SpecSeal Series LCI Intumescent Sealant
 - c. SpecSeal Series LC Endothermic Sealant
 - d. SpecSeal Series AS Elastomeric Spray
 - e. SpecSeal Series ES Elastomeric Sealant
 - 2. Firestop Devices: Factory-assembled steel collars lined with intumescent material sized to fit specific outside diameter of penetrating item, the following products are acceptable:
 - a. SpecSeal Series SSC Firestop Collars
 - b. SpecSeal Series LCC Firestop Collars
 - 3. Fire Rated Cable Pathways: STI EZ-PATH[™] Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
 - a. EZ-PATH[™] Fire Rated Pathway
 - 4. Wall Opening Protective Materials: Intumescent, non-curing pads or inserts for protection of electrical switch and receptacle boxes to reduce horizontal separation to less than 24", the following products are acceptable:
 - a. SpecSeal Series SSP Firestop Putty Pads
 - b. SpecSeal Series EP PowerShield Insert Pads
 - 5. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
 - a. SpecSeal Series SSP Firestop Putty
 - 6. Wrap Strips: Single component intumescent elastomeric strips faced on both sides with a plastic film, the following products are acceptable:
 - a. SpecSeal Series RED2 Wrap Strip
 - b. SpecSeal Series BLU2 Wrap Strip
 - 7. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated with an intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
 - a. SpecSeal Series SSB Firestop Pillows
 - 8. Mortar: Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar, the following products are acceptable:
 - a. SpecSeal Series SSM Firestop Mortar
 - 9. Silicone Sealants: Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or nonsag) or vertical surface (nonsag), the following products are acceptable:
 - a. SpecSeal SIL300 Silicone Firestop Sealant
 - b. SpecSeal SIL300 SL Self-Leveling Silicone Firestop Sealant



- 10. Silicone Foam: Multicomponent, silicone-based liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam, the following products are acceptable:
 - a. Pensil 200 Silicone Foam
- 11. Composite Sheet: Intumescent material sandwiched between a galvanized steel sheet and steel wire mesh protected with aluminum foil, the following products are acceptable:
 - a. SpecSeal CS Composite Sheet
- 12. Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket, the following products are acceptable:
 - a. SpecSeal CD Cast-In Firestop Device
- 13. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use on steel HVAC ducts, the following products are acceptable:
 - a. SpecSeal FyreFlange Firestop Angles
- 14. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material for use in blank openings and cable sleeves, the following products are acceptable:
 - a. SpecSeal Series FP Firestop Plug
- 15. Fire-Rated T Rating Collar Device: Louvered steel collar system with synthetic aluminized polymer coolant wrap installed on metallic pipes where T Ratings are required by applicable building code requirements, the following products are acceptable:
 - a. SpecSeal T-Collar Device
- 16. Fire-Rated Cable Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing individual cable penetrations up to 0.27 in. diameter, the following products are acceptable:
 - a. Ready Firestop Grommet
- D. Smoke and Acoustical sealants: Specified in Section 07 92 00.
- E. Color: to be selected by architect.
- F. Or equal in accordance with Division 01, General Requirements.

2.03 FIRESTOPPING AT ELECTRICAL BOXES AND UTILITY OUTLETS

- A. Steel electrical outlet boxes on opposite sides of walls requiring protected openings shall be separated by horizontal distance of 24 inches.
- B. Steel electrical outlet boxes that occur in combination with outlet boxes of size such that aggregate area of unprotected outlet boxes exceeds 100 square inches in any 100 square feet of wall area shall be protected by approved material or detail to decrease aggregate area of unprotected utility boxes to less than 100 square inches in any 100 square feet of wall.
- C. Steel electrical outlet boxes that do not exceed 16 square inches in area shall be protected by an approved firestop material: at each side of wall:

- 1. CP 617 and CP 617L MOLDABLE FIRESTOP PUTTY PADS, by Hilti Inc. Tulsa, OK
- 2. MPP-4S MOLDABLE PUTTY PADS, by 3M Contractor Products, Minneapolis, MN.
- 3. FSP FIRESTOP PUTTY PADS, by Hevi-Duty Nelson Products, Tulsa, OK.
- 4. SPECSEAL PUTTY PADS, By Specified Technologies, Inc., Somerville NJ.
- 5. Johns Manville, Denver CO. Firetemp Puddy Pad.
- 6. Or equal as approved in accordance with Division 01, General Requirements for Substitutions.
- D. Utility and electrical outlets or boxes shall be securely fastened to the stud or framing of the wall, or ceiling assembly. The opening in the gypsum board facing shall be cut so that the clearance between the box and the gypsum board does not exceed 1/8 inch.
 - 1. In smoke walls the 1/8 inch clearance shall be filled with an approved fire-rated sealant.

2.04 SAFING INSULATION - PERIMETER FIRE CONTAINMENT SYSTEMS

- A. Mineral Wool / Fire Safing Insulation: 4-inch thick, 4 pcf, noncombustible, moisture-resistant, noncorrosive, non-deteriorating, synthetic vitreous fiber bound in a matrix.
 - 1. Fiber: rock- or slag-wool fiber, or man-made vitreous fiber
 - 2. ASTM E 136, Combustibility: NFPA Standard 220, non-combustible
 - a. ASTM E 84, Flame Spread Index: 0
 - b. ASTM E 84, Smoke Developed Index: 0
 - 3. Recycled Content: 70-percent, minimum
 - 4. Acceptable Products: Thermafiber, Safing Insulation, Johns Manville MinWool Safing.
- B. Fill, Void or Cavity Material: Static; USG Types FC (1" Firecode Compound), RFC (Ready Mixed Firecode Compound). UL Listed, R11822
- C. Locations: as indicated in drawings, and at all gaps, crevices and openings between multistory floors and walls requiring Fire Rated protection.
- D. Insulation shall be as approved in accordance with Division 01, General Requirements for substitutions and shall be UL listed.
 - Curtain Wall Insulation; Mineral wool, Foil-Faced Thermafiber CW Firespan 90, 2 inches thick panel insulation and 1 inch thick by 8 wide at aluminum mullions, or 4 inches thick at stud walls. Opposite side faced with black mat. Secure with impaling pins and clinch shields at 12 inches on center, attach impaling pins to perimeter steel angles, 2" x 2" x2", screw attached to mullion. Install a steel angle horizontally behind insulation at safing line. ICC-ES Legacy Report No. VAR-1025 and ER-2331.

- Safing: Mineral wool, Thermafiber LLC, Thermafiber Safing Insulation Type SAF, 4 inches thick min. at all floors between aluminum curtain wall or framed stud walls and concrete floors or concrete/metal deck floors. Compression fit and support with safing Z-clips at 12 inches o.c. Install 1 inch thick USG Firecode Compound, Types FC, RFC, tight over entire safing. Fire Hazard Classification, Flame Spread 15, Smoke Developed 0, shall meet Federal Specifications HH-1-521E, Type I, Class A/HH-1-521E, Form A, Classes 1 and 2, THERMAFIBER SAFING INSULATION, ICC-ES Legacy Report No. VAR-1025 and ER-2331.
- 3. THERMAFIBER LLC, Wabash, Indiana. Firespan Insulation, UL R4643.
 - a. UL System Number: CW-S-1001, 5/8" thick Exterior Fire Code Gypsum Board or Cement Board spandrel sheathing substrate over steel stud framed wall and exterior finish.
 - b. UL System Number: CW-S-2001 [CW-D-2001], 1/4" Spandrel Glass.
 - c. UL System Number: CW-S-2002 [CW-D-2002], 1/8" thick aluminum spandrel panel with 1/4" thick edges.
- 4. Any Perimeter Fire Containment System per UL XHDG and UL XHGU.
- E. Spandrel panel assembly shall meet requirements for two-hour fire rating.

2.05 ACCESSORIES

- A. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
 - 1. Permanent forming/damming/backing materials.
 - 2. Substrate primers.
 - 3. Collars.
 - 4. Steel sleeves.
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Verify site conditions.
 - B. Verify that openings are ready to receive Work of this Section.
- 3.02 PREPARATION
 - A. Clean substrate surfaces of dirt, dust, grease, oil, loose material or other matter that may affect bond of firestopping material.
 - B. Remove incompatible materials that affect bond.
 - C. Install backing materials to arrest liquid material leakage.
- 3.03 APPLICATION
 - A. Install fluted through penetration firestopping system per Section 05 40 00.

- B. Apply primer, firestop sealant or other firestop materials in accordance with manufacturer's recommendations and as approved by regulatory agencies. Apply at voids between fire-rated assemblies and adjoining fire-rated materials or assemblies.
- C. Apply firestopping materials with sufficient thickness or configuration to achieve designated fire rating.
- D. Install firestopping material in locations where designated fire rating must be maintained, including, but not limited to following:
 - 1. Voids or annular openings around sleeves, piping, ductwork or electrical/communications conduits that penetrate fire rated walls, partitions, floors, ceilings or assemblies.
 - 2. Intersections of fire-rated vertical and horizontal assemblies, including but not limited to door and window frames.
- E. Remove dam material after firestopping material has cured.
- F. Safing Insulation: Install compression fit and with support accessories specified where required.
- 3.04 IDENTIFICATION
 - A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- 3.05 CLEANING
 - A. Clean adjacent surfaces of firestopping materials.
- 3.06 PROTECTION OF FINISHED WORK
 - A. Protect finished Work.
 - B. Protect adjacent surfaces from damage by material installation.
- 3.07 INSPECTION
 - A. Notify Inspector before Work is covered. Approval of Inspector shall be received before any Work is concealed in manner that will make inspection difficult. Work that has been covered prior to inspection and approval shall be uncovered, inspected and recovered.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Preparing substrate surfaces.
 - B. Sealant and joint backing.
 - C. Related Section:1. Section 07 84 00 Firestopping. For fire-rated assemblies.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ASTM C834 Latex Sealing Compounds.
 - C. ASTM C881 Epoxy-Resin Base Bonding Systems for Concrete.
 - D. ASTM C919 Use of Sealants in Acoustical Applications.
 - E. ASTM C920 Elastomeric Joint Sealants.
 - F. ASTM D1056 Flexible Cellular Materials Sponge or Expanded Rubber.
 - G. ASTM C1184 Structural Silicone Sealant.
 - H. ASTM C1193 Standard Guide for Use of Joint Sealants.
 - I. ASTM C1311 Solvent Release Sealants. Butyl and acrylic base polymer.
 - J. ASTM C1330 Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
 - K. SWRI (Sealant, Waterproofing and Restoration Institute) Sealant and Caulking Guide Specification (www.SWRIONLINE.org).
 - L. GANA: Glass Association of North America Sealant Manual, 2008.
 - M. SDAPCD San Diego County Air Pollution Control District, Regulation IV.
- 1.03 SUBMITTALS
 - A. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

- B. Manufacturer's installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.
- C. Pre-Construction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing Article.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform acoustical sealant application work in accordance with ASTM C919.
- C. Prepare sample joints in the construction to demonstrate to the Architect the quality of the Work to be performed. Accepted sample joints will be used to judge the quality of the Work.
- D. Qualifications
 - 1. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum three years experience.
 - 2. Applicator:
 - a. Pre-qualified applicator specializing in performing Work of this Section with minimum three years experience and approved by manufacturer.
 - b. This applicator shall be licensed joint sealing specialty Contractor.
 - c. Submit list of completed local projects of similar sealant applications.
- E. Comply with Air Quality regulations, California Regulations:1. SCAQMD Rule 1168 compliant VOC limit of 250.
- 1.05 ENVIRONMENTAL REQUIREMENTS
 - A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.
- 1.06 COORDINATION
 - A. Coordinate the Work with all Sections referencing this Section.
- 1.07 WARRANTY
 - A. Provide five-year product warranty, submit under provisions of Division 01, General Requirements.
 - B. Provide two-year installer's warranty, submit under provisions of Division 01, General Requirements.
 - C. Warranty: Include coverage for installed sealants and accessories which fail to achieve air tight seal, water tight seal, exhibit loss of adhesion or cohesion, or do not cure.
D. Upon written notification of failure due to defective materials or application, repair or replace failure to the approval of the Architect and at no cost to Owner.

PART 2 - PRODUCTS

2.01 SEALANT AND MATERIAL MANUFACTURERS

- A. Following is list of acceptable manufacturers of sealants and sealant materials. Inclusion in this list is not intended to imply that all manufacturers make all products. Products made by listed manufacturers must comply with all specified requirements.
 - 1. Bostik Construction Products.
 - 2. Dow Corning Corporation (www.dowcorning.com/construction)
 - 3. Sika Corporation.
 - 4. General Electric Company.
 - 5. W.R. Meadows, Inc.
 - 6. Pecora Corporation.
 - 7. Mameco International.
 - 8. Tremco/Vulkem.
 - 9. Sonneborn, ChemRex Inc.
 - 10. Hilti
 - 11. 3M Company
- B. Substitutions: Under provisions of Division 01, General Requirements.
- 2.02 SEALANT TYPES
 - A. Single-Component Urethane: ASTM C 920, Type S, Grade NS, Class 35, Use NT, A, M, and O; USDA and FDA status.
 - B. Single-Component Urethane (Self-Leveling): ASTM C 920, Type S, Grade P, Class 35, Use T, A, M.
 - C. Multi-Component Urethane (Gun-Grade): ASTM C 920, Type M, Grade NS, Class 35, Use NT, A, M, and O.
 - D. Multi-Component Polyurethane (Gun-Grade): ASTM C 920, Type M, Grade NS, Class 35, Use T, A, M, and O.
 - E. Multi-Component Urethane (Self-Leveling): ASTM C 920, Type M, Grade P, Class 25, Use T, A, M, and O.
 - F. Single-component sealant, Silicone (Neutral-curing): ASTM C 920, Type S, Grade NS, Class 35, Use NT, G, A, M, and O; USDA, NSF and FDA 21 CFR 177.2600 approved.
 - G. Single-component sealant, Silicone (Neutral-curing,): ASTM C 920, Type S, Class 100/50, Grade P, Use T, and O.

- H. Single-component, modified silicone polymer (silyl-terminated polyether resin STPe), elastomeric sealant with plus-100-percent to minus-50-percent movement and complying with ASTM C-920, Type S, Grade NS, Uses NT, G, M, A, and O.
 - 1. Acceptable Product: BASF, Sonolastic 150 Tint Base, or equal. Color shall be as selected by the Architect from the manufacturer's full range of available colors.
- I. Acrylic-Latex Caulk: ASTM C 834, Type OP or C, Grade 18 deg. C.
- J. Bedding Compound: For installation of thresholds and similar items indicated to be bedded in sealant, use a preformed butyl-polyisobutylene sealant tape. Size of tape as required for the specific application.
- K. Adhesives: Type that complies with Mil. Spec. MIL-A-46146
 - 1. Product: Dow Corning 3145 Silicone Adhesive
 - 2. Color: Clear or Translucent.
 - 3. Peel Strength: 75
- L. Acoustical Sealant gunnable type, non-drying, non-hardening permanently flexible, ASTM C919, ASTM C834, ASTM C920.
 - 1. Manufacturers: Tremco Acoustical Sealant, U.S. Gypsum Sheetrock Acoustical Sealant, Pecora Corp. BA-98 or equal.
- M. Fire-Rated Sealants: Per Section 07 84 00 Firestopping.
- N. Butyl Sealants: Butyl rubber sealant, BC-158 by Pecora or equal in compliance with VOC regulations of local Air Quality Districts.
- O. Insulating Foam Sealants: two component polyurethane foam and dispensing kit, commercial grade, UL Classified, for professional application. "Froth-Pak" Foam Sealant by Dow Chemical, or equal.
- 2.03 JOINT AND SURFACE TYPES
 - A. Pedestrian and Vehicle Traffic Joints Provide one of the following for each joint type:
 - 1. Multi-component urethane (self-leveling)
 - 2. Single-component urethane (self-leveling)
 - 3. Single-component sealant, silicone (neutral curing)
 - B. Non-Traffic Deck Joints Provide one of the following for each joint type:
 - 1. Multi-component urethane (gun-grade)
 - 2. Single-component urethane
 - 3. Single-component sealant, silicone
 - C. Concrete Surfaces exceeding 20 square feet.
 - D. Single-Component Silicone (Neutral-curing,): ASTM C 920 Class 25, Type S, Grade P, Use T, and O (self-leveling).
 - E. Vertical Joints Provide one of the following for each joint type:
 - 1. Multi-component urethane (gun-grade)

- 2. Single-component sealant, silicone (neutral cure)
- F. Expansion, Control, and Perimeter Joints Provide one of the following for each joint type:
 - 1. Multi-component urethane (self-leveling)
 - 2. Single-component urethane; use only where dynamic movement will not exceed 50 percent of joint width above or below grade
 - 3. Single-component urethane (self-leveling)
 - 4. Single-component sealant, silicone.
- G. Acoustical Sealant gunnable, provide the following:
 - 1. Non-drying, non-hardening, non-skinning sealant type, ASTM C919.
 - 2. Acrylic-latex caulk, Type OP opaque or Type C clear at visual locations, ASTM C834.
 - 3. Chemically curing Sealant, for interior sound reduction application, ASTM C920.
- H. Acoustical Putty Pads QuietPutty 380 by QuietRock or equal.
 - 1. Thickness: 1/8"
 - 2. Width: 7"
 - 3. Length: 7"
 - 4. Surface Burn, Class A
- I. Smoke and Acoustical Sealant: ASTM C834, Hilti CP 506.
- J. Exterior Doors and Windows: Sealant used for exterior joints or butyl rubber.
 1. Fire-rated sealant at fire-rated assemblies per Section 07 84 00.
- K. Interior Doors and Windows Provide one of the following for each joint type:
 - 1. Single-component sealant, silicone (neutral cure)
 - 2. Fire-rated sealant at fire-rated assemblies per Section 07 84 00.
- L. Built-In Cabinet Work: In kitchen, toilet, and bath areas, as specified for those areas. In other areas, single-component silicone (neutral-curing) or acrylic-latex caulk.
- M. Rated Walls: Fire-rated Sealant, per UL Systems classification and in accordance with Section 07 84 00.
 - 1. Fire-rated sealant between rated walls or ceilings and their adjoining rated materials and construction, including but limited to door and window frames.
- N. Miscellaneous locations: Butyl rubber at all gaps, holes, openings, under wood sills, penetrations or channel metal track in exterior envelope of building not identified herein. Install as directed by the Architect.
- O. Seal all cutouts and penetrations: For electrical, mechanical, plumbing and structural framing cutouts and penetration at interior surfaces with acoustical sealant and fire-rated sealant for rated walls per section 07 84 00, or butyl rubber for exterior surfaces including walls.
- P. Correctional Facilities: Use security sealant at all joints at detention cells and as indicated.

2.04 SEALANT COLORS

- A. Provide materials matching colors indicated or if no color is indicated, matching the color samples selected from those submitted to the Architect.
 - 1. Sealant between walls and door, window, and louver frames to match adjacent wall color.
- 2.05 ACCESSORIES
 - A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
 - B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
 - C. Joint Backing Rod: ASTM C1330 Class C, closed cell polyethylene cylindrical backer rod; oversized 30 to 50 percent larger than joint width, Green Rod by Nomaco Inc., Zebulon, NC, Backer Rod Mfg. Denver, CO or equal.
 - D. Elastomeric Tubing Sealant Backing: ASTM D1056 Flexible Cellular Materials Sponge or Expanded Rubber.
 - E. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.
 - F. Filler: Mineral fiber board; ASTM C612, Class1, thickness same as joint, depth to fill void completely behind backer-up rod.
 - G. Tape Sealants: pressure sensitive, 100% solid, sealing tape with a release paper backing. Provide permanent elastic, non-sagging, non-toxic, non-staining tape sealant. Schnee-Morehead Inc. "Tacky Tape" SM5227, 3/32" or 1/2" wide x 3/8" thick x 45' long, or equal.
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Verify that substrate surfaces and joint openings are ready to receive Work.
 - B. Verify that joint backing and release tapes are compatible with sealant.
- 3.02 PREPARATION
 - A. Remove loose materials and foreign matter which might impair adhesion of sealant.
 - B. Clean and prime joints in accordance with manufacturer's instructions.
 - C. Perform preparation in accordance with manufacturer's instructions.
 - D. Protect elements surrounding the Work of this Section from damage or disfiguration.

- E. At deep joints install filler material to fill space behind the back-up rod and position the rod at proper depth.
- 3.03 INSTALLATION
 - A. Do not proceed with sealant Work until the sample joints specified in Part 1 of this Section have been prepared and accepted by the Architect.
 - B. Install sealant in accordance with manufacturer's instructions and ASTM C1193.
 - C. Apply sealant per ASTM C919 at gypsum board framed sound walls, side of runners in metal framing and miscellaneous openings and cutouts.
 - D. Measure joint dimensions and size materials to achieve required 2:1 width/depth ratios.
 - E. Install joint backing to achieve a neck dimension no greater than 1/3 of the joint width.
 - F. Install bond breaker where joint backing is not used.
 - G. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
 - H. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
 - I. Tool joints concave unless detailed otherwise.
- 3.04 CLEANING
 - A. Clean adjacent soiled surfaces.
- 3.05 PROTECTION OF FINISHED WORK
 - A. Protect finished installation under provisions of Division 01, General Requirements.
 - B. Protect sealants until cured.

END OF SECTION

SECTION 08 12 14

HOLLOW METAL FRAMES - KNOCK-DOWN

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Non-rated fire-rated knock-down field assembled frames.
 - 1. ANSI A250.8/SDI-100, Level 2, 16 gauge Frames.
- B. Related Sections:
 - 1. Section 08 71 00, Door Hardware.
 - 2. Refer to drawings for Finish Schedule
 - 3. Section 09 90 00, Painting.

1.02 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. ADA Americans with Disabilities Act of 1990, as amended.
 - 1. ADA Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design.
- C. CBC 2016 California Building Code.
- D. ASTM American Society for Testing and Materials
 - 1. ASTM A653 Standard Specifications for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A1008 Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - 3. ASTM E152 Fire Tests of Door Assemblies.
- E. ANSI A250.10 Test Procedure and Acceptance Criteria for Prime Steel Surfaces for Steel Doors and Frames.
- F. SDI Steel Door Institute
 - 1. SDI-105 Recommended Erection Instructions for Steel Frames.
 - 2. SDI-111 Recommended Standard Details Steel Doors and Frames.
 - 3. SDI-117 Manufacturing Tolerances Standard Steel Doors and Frames.
 - 4. SDI 118 Basic Fire Door Requirements.
- G. Standard 12-7-4 Fire Resistive Standards, Fire Door Assemble Tests California Referenced Standards Code, CCR Title 24, Part 12.
- H. NFPA 80-2007- Fire Doors and Fire Windows

1.03 SUBMITTALS

- A. Shop drawings indicating frame configuration, anchor types and spacings, location of cutouts for hardware, reinforcement and finish.
- B. Product data.
- C. Manufacturer's installation instructions.
- 1.04 DELIVERY, STORAGE AND PROTECTION
 - A. Deliver and protect and frames with manufacturer's safeguards.

PART 2 - PRODUCTS

- 2.01 MANUFACTURERS
 - A. Products of following manufacturers form basis for design and quality intended.
 1. Any manufacturer belonging to the Steel Door Institute, Cleveland, OH.
 - B. Any manufacturer providing certification of compliance with standards of fabrication, insulation, finish and testing required in current issues of SDI Specification Guides and as approved in accordance with general requirements for substitutions.
- 2.02 KNOCK-DOWN FIELD FRAMES
 - A. Type: ANSI A250.8/SDI-100, Level 2, 16 gauge, self-aligning, factory fabricated jamb and head units with integral stop and flat trim, double rabbet, profiles as indicated on the drawings, cold rolled steel.
 - 1. Drywall: Provide back bend.
 - 2. Plaster: Provide plaster key.
 - 3. Openings 48 inches wide or less: 16 gauge.
 - B. Corner Reinforcement: 18 gauge channel shaped to provide precision alignment of jamb and head, factory welded to head component.
 - C. Anchors: Provide two field inserted steel lock-in type anchors at doors up to 48 inches in width, three if wider, maximum 30 inches on centers. Provide three at jamb for doors up to 84 inches in height, additional anchors at maximum 30 inches on centers for higher doors.
 - Floor Attachment: Install metal anchor with provision for expansion anchor attachment to concrete floor, adjustable for height, welded in place. Minimum thickness: 12 gauge.
 - E. Hardware Attachment: Mortise, reinforce, drill and tap at factory to receive specified mortised hardware. Install minimum 10 gauge reinforcing welded to frame for surface mounted hardware, except install 3/16 inch thick reinforcing for hinges. Tap to templates.

- F. Silencers: Make provisions for minimum three rubber silencers at strike jamb of all doors except fire-rated doors, and one at head of each leaf of double doors except fire-rated doors.
- G. Finish:
 - 1. Interior Frames: Primer meeting requirements of ANSI A250.10, shop applied.
 - a. Finish: Factory pre-coated, color as selected by Architect.
 - 2. Exterior Frames:
 - a. Galvanizing required, types permitted: Zinc-coated carbon steel complying with ASTM A653/A653M, G60 or Galvannealed A60, commercial quality or drawing quality, hot-dip galvanized.
 - b. Pretreat and shop prime with modified alkyd, air-dried, conforming to ANSI A250.10.
 - c. Finish: Factory pre-coated, color as selected by Architect.
 - d. Wipe coat galvanized steel is not permitted.
- H. Fire Rated Frames:
 - 1. Construct as tested and rated in accordance with UL 10C or NFPA 252.
 - 2. Attach UL or WH Label to frame.
- 2.03 FABRICATION
 - A. Fabricate frames for knock-down field assembly type.
 - B. Fabricate frames with hardware reinforcement plates welded in place.
 - C. Fabricate frames to accept anchors as described in SDI-111 for type of wall construction.
 - D. Reinforce frames for door checks on both sides, where required.
- PART 3 EXECUTION
- 3.01 INSTALLATION
 - A. Install frames in accordance with SDI-105.
 - B. Fire rated doors and frames shall be installed in accordance with their listing NFPA No. 80 and the manufacturer's instructions.
 - C. Coordinate anchor placement with type of wall construction.
 - D. Colors: per finish schedule in drawings.
- 3.02 TOLERANCES
 - A. Conform to standard of tolerances as required in SDI-117.

END OF SECTION

SECTION 08 13 13

HOLLOW METAL DOORS

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Non-rated and Fire-rated rolled-steel doors.
 - B. Related Sections:1. Refer to drawings for Finish Schedule
- 1.02 REFERENCE STANDARDS
 - A. Conform to reference standards by date of issue current on date of Contract Documents.
 - B. ADA Americans with Disabilities Act of 1990, as amended.
 - 1. ADA Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design.
 - C. SDI Steel Door Institute.
 - 1. SDI 100 Recommended Specifications for Standard Steel Doors and Frames, Latest Edition.
 - 2. SDI 118 Basic Fire Door Requirements.
 - 3. SDI 111 Standard Details Steel Doors and Frames .
 - 4. SDI 117 Manufacturing Tolerances Standard Steel Doors and Frames.
 - D. ANSI American National Standards Institute
 - 1. ANSI A250.4 Test Procedures and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcings.
 - 2. ANSI A250.5 Accelerated Physical Endurance Test Procedure for Steel Doors, Frames, and Frame Anchors.
 - 3. ANSI A250.8/SDI 100 Recommended Specifications for Standard Steel Doors and Frames.
 - 4. ANSI A250.10 Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
 - 5. ANSI A250.11/105 Recommended Erection Instructions for Steel Frames.
 - E. ASTM American Society for Testing and Materials
 - 1. ASTM A653 Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A924 General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - 3. ASTM A1008 Standard Specifications for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - 4. ASTM A568 General Requirements for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.

- F. CBC 2016 California Building Code
 - 1. CBC-10 CBC Chapter 10, Means of Egress
 - 2. CBC-11 CBC Chapter 11B, Accessibility to Public Buildings, Public Accommodations, Commercial Facilities and Publicly Funded Housing
- G. CRSC California Referenced Standards Code (CCR Title 24, Part 12)
 - 1. CRSC-7A.4 Standard 12-7-4 Fire Resistive Standards, Fire Door Assemble Tests
 - 2. CRSC-7A.2 Standard 12-7A-2, Exterior Windows
 - 3. CRSC-10.2 Standard 12-10-2 Single Point Latching or Locking Devices
 - 4. CRSC-10.3 Standard 12-10-3 Emergency Exit and Panic Hardware
- H. NFPA National Fire Protection Association
 - 1. NFPA 80 Fire Doors and Windows
 - 2. NFPA 105 Installation of Smoke Door Assemblies
 - 3. NFPA 252 Standard Methods of Fire Tests of Door Assemblies
- I. UL Underwriters Laboratories, Inc.
 - 1. UL 10C Positive Pressure Fire Tests of Door Assemblies
 - 2. UL 1784 Air Leakage Test for Door Assemblies
- J. ITS-WH Intertek Testing Services-Warnock-Hersey.
- 1.03 SUBMITTALS
 - A. Shop drawings indicating core material, location of cutouts for hardware, reinforcement and finish.
 - B. Product data.
 - C. Manufacturer's installation instructions.
- 1.04 QUALITY ASSURANCE
 - A. Manufacture doors to conform to SDI standards except where exceeded by this Specification.
 - B. Comply with ANSI/SDI A250.4 Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcings. Level A, one million cycle swing test performance.
 - C. ADA-The Americans with Disabilities Act Title II-Uniform Federal Accessibility Standards.
- 1.05 DELIVERY, STORAGE AND PROTECTION
 - A. Deliver and protect doors with manufacturer's shipping safeguards.

- B. Storage: Store in dry secure location. Place units on minimum 4-inch high wood blocking. Avoid non-vented plastic or canvas shelters. Provide 1/4-inch wide spaces between stacked doors.
- 1.06 WARRANTY
 - A. One-year warranty against defects in materials and workmanship. Warranty to commence at Date of Certified Substantial Completion.
- PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Products of following manufacturers form the basis for design and quality intended.
 - 1. Ceco Door, Milan, TN.
 - 2. Curries Company, Mason City, IA.
 - 3. Door Components, Inc., Fontana, CA.
 - 4. Mesker Doors, Huntsville, AL.
 - 5. Republic Doors and Frames, McKenzie, TN.
 - 6. SteelCraft, an Allegion Brand, Dublin, Ireland.
- B. Or equal in accordance with General Requirements for Substitutions.
- 2.02 DOORS
 - A. Exterior Doors: ANSI A250.8/SDI-100, 1-3/4 inches thick, Model 2 Seamless, 16 gauge cold-rolled face sheets, ASTM A653/A-653M, Seamless, continuously welded seam dressed smooth, hollow-steel construction, sizes as scheduled on drawings. Close top and bottom with flush end closures, make top closures watertight. Beveled edge profile. G-90 Galvanize Door for exposed galvanized finish with no finish coatings.
 - B. Interior Doors: ANSI A250.8/SDI-100, Level 2, Heavy-Duty, Physical Performance Level B, 1-3/4 inches thick, Model 2 Seamless, 18 gauge cold-rolled face sheets, ASTM A1008, seamless continuously welded seam dressed smooth, hollow-steel construction, Close top and bottom with flush end closure, beveled edge profile, sizes as scheduled on drawings, prime coated only.
 - C. End Closures: Minimum 18 gauge.
 - D. Fire Rated Doors Assembly: Test in accordance with NFPA 252.
 - E. Fire Rated Doors: Label "S" for smoke assembly requirements, NFPA 80, NFPA 105.

2.03 DOOR CORE

- A. Performance Test Procedures Requirements: Conform to ANSI A250.4
- B. Core for non-fire-rated doors:1. Core for exterior doors:



- a. Thermal-Rated (Insulated) doors: minimum polystyrene 1 lb/cu ft. density of U-factor 0.21 minimum and R-Factor of 5 minimum, full thickness of cavities.
- 2. Core for interior doors:
 - a. Rigid polystyrene foam board 1 lb/cu.ft. minimum density. Compressive strength 1750 psf and shear strength minimum 18 psi.
- 3. Core construction shall conform to requirements of the grade of door specified in accordance with ANSI A250.8/SDI-100, Sections 2.3.2 and 1.4.
- C. Core for Fire-Rated Doors: mineral core 16-20 lb. density (incombustible). Conform to Door Schedule for fire rating required.
- D. Frames for Fire-Rated Doors: Conform to CRSC California Referenced Standards Code, Standard 12-7-4, fire door tests, Label "S" for smoke assembly requirements NFPA 105 and Section 08 12 13.
- 2.04 PROTECTIVE COATINGS
 - A. Interior Doors:
 - 1. Metallic-coating protection not required.
 - 2. Pre-treat and shop prime with modified alkyd, air-dried, conforming to ANSI A250.10.
 - B. Exterior Doors:
 - 1. Metallic coating protection required, types permitted: ASTM A653/A-653M, hot-dip galvanized, zinc-coated Commercial Steel, G60 Grade coating designation
 - 2. Pre-treat and shop prime with modified alkyd, air-dried, conforming to ANSI A250.10.
 - 3. Finish paint doors under Section 09 90 00, colors per Section 09 06 00.
 - C. On surfaces where zinc has been damaged or removed during fabrication, doors shall be touched-up with factory-applied primer.

2.05 FABRICATION

- A. Fabricate doors from cold-rolled steel conforming to ASTM A1008/A1008M or ASTM A924. Stretcher-leveled standard of flatness for face sheets.
- B. Manufacturing tolerances per SDI 117 Manufacturing Tolerances Standard Steel Doors and Frames.
- C. Fabricate doors with cutouts sized for hardware and openings as indicated. Non-handed doors using hinge fillers are not permitted.
- D. Reinforce, drill and tap doors to receive mortise hinges, locks, latches, flush bolts and closer. Use reinforcing gauges as listed in Table 4 of ANSI A250.8/SDI-100. Channel or plate reinforcing only.
- E. Locate hardware according to Table 5, ANSI A250.8/SDI-100, CBC 11B-404.2.7.

- F. Apply primer to all surfaces of doors in accordance with requirements of ANSI A250.10. Metallic-coated surfaces shall be pre-treated prior to application of primer.
- G. Attach fire-rated label to hinge-stile of each fire-rated door unit and frames.
- H. Hardware Enclosures: Provide enclosures and junction boxes within doors for electrically operated door hardware, interconnected with UL-approved, 1/2-inchdiameter conduit and connectors. Delete subparagraph below if not required.Where indicated for installation of wiring, provide access plates to junction boxes, fabricated from same material and thickness as face sheet and fastened with at least 4 security fasteners spaced not more than 6 inches on centers.

PART 3 - EXECUTION

- 3.01 INSTALLATION OF HOLLOW METAL DOORS
 - A. Install doors in accordance with SDI ANSI A250.11/105 and SDI 122 recommendations.
 - B. Install doors under this Section.
 - C. Coordinate installation of glass or louvers where indicated.
- 3.02 INSTALLATION OF HARDWARE
 - A. Install hardware in accordance with Section 08 71 00, Door Hardware.
 - B. Exit Devices shall comply with in accordance with CBC 2016 Sections 1008.1.9 and 11B-404.2.7, mounted 34 inches to 44 inches above finish floor, comply with Standard 12-10-3. The unlatching force shall be by Authority having Jurisdiction and may increase the maximum effort to operate doors required to be fire rated to achieve positive latching, but in no case shall the pressure exceed 15 pounds per CBC Section 11B-404.2.9 when applied in the direction of exit travel.
 - C. 5 lbs pressure maximum for interior/exterior at non rated doors per 2016 CBC 11B-404.2.
 - D. Conform to SDI-107 and SDI-109 for hardware on steel doors.
 - E. Fire doors and frames assembly shall be installed in accordance with their listing per NFPA No. 80 and testing per NFPA 252, and the manufacturer's instructions.
- 3.03 INSTALLATION TOLERANCES
 - A. Conform to standard of flatness and squareness as required by SDI-117. Maximum Diagonal Distortion: 1/16 inch measured with straight edge corner to corner, or as required to meet door warranty.

3.04 FIELD QUALITY CONTROL

- A. Provide testing certification of fire-rated door assemblies in accordance with CBC Section 716.5 and Fire-Resistive Standard 12-7-4.
- B. Provide manufacturer's installation instructions for each listed assemblies for review by the Inspection Authority.
- 3.05 ADJUSTING AND CLEANING
 - A. Adjust for smooth and balanced door movement.
 - B. Paint doors under Section 09 90 00.

END OF SECTION

SECTION 08 41 13

ALUMINUM ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Aluminum doors, frames, glazing components and glazed lights.
 - B. Glass panels.
 - C. Anchors, brackets and attachments.
 - D. Related Sections
 - 1. Section 08 71 00, Door Hardware.
 - 2. Refer to Drawings
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ASTM American Society for Testing and Materials
 - 1. ASTM A36 Structural Steel.
 - 2. ASTM A123 Zinc (Hot-Dip Galvanized) coatings on Iron and Steel Products.
 - 3. ASTM B221 Aluminum-Alloy Extruded Bar, Rod, Wire, Shape and Tube.
 - 4. ASTM E283 Rate of Air Leakage through External Windows, Curtain Walls and Doors.
 - 5. ASTM E330 Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
 - 6. ASTM E331 Water Penetration of Exterior Windows, Curtain Walls and Doors.
 - 7. AAMA American Architectural Manufactures Association: AAMA 501 Methods of Test for Exterior Walls. (Mfg's mock up tested in lab).
 - 8. AAMA TIR-A11-04 Maximum Allowable deflection of Framing Systems for Building Cladding Components at Design Wind Loads.
 - C. ADA Americans with Disabilities Act of 1990, as amended.
 - a. ADA Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design.
 - D. CBC 2016 California Building Code.
 - E. DSA The Division of the State Architect.
 - F. ICC International Code Council.

G. CPSC 16 CFR 1201– U.S. Consumer Products Safety Commission, Safety Standard for Architectural Glazing Material, Consumer Protection Safety Commission, Code of Federal Regulations. All glazing shall be tested in accordance with CPSC 16 CFR 1201. Glazing shall comply with the test criteria for Category II as indicated in Table 2406.2(1), 2016 CBC.

1.03 SYSTEM DESCRIPTION

- A. Performance Requirements
 - 1. System to provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F without causing detrimental effects to system or components.
 - 2. Design and size members to withstand dead loads and live loads caused by pressure and suction of wind as calculated in accordance with requirements of Chapter 24, and Chapter 16A Section 1609A of CBC and ASCE 7 Chapter 6.
 - 3. Limit water infiltration to zero at 8 pounds-force per square foot, ASTM E331. 8 for Arcadia A400 Series
 - 4. System to accommodate, without damage to system or components, or deterioration of perimeter seal: Movement within system; movement between system and perimeter framing components; dynamic loading and release of loads; and deflection of structural support framing.
 - 5. When a pair of doors is used, one of the doors to provide clear, unobstructed opening 32 inches in width with the door positioned at an angle 90 degrees from its closed position.

1.04 SUBMITTALS

- A. Shop drawings including system and component dimensions; components with in assembly; framed opening requirements and tolerances; anchorage and fasteners; glass and infills; door hardware requirements; and affected related work.
- B. Product data
- C. Manufacturer's installation instructions.
- D. Three samples, illustrating pre-finished aluminum surface and specified glass.
- 1.05 DELIVERY, STORAGE AND HANDLING
 - A. Provide wrapping or strippable coating to protect pre-finished aluminum surfaces.
- 1.06 QUALITY ASSURANCE
 - A. Qualifications:
 - 1. Installer Qualifications: Installer experienced (as determined by contractor) to perform work of this section who has specialized in the installation of work similar to that required for this project and who is acceptable to product manufacturer.

- 2. Manufacturer Qualifications: Manufacturer capable of providing structural calculations, applicable independent product test reports, installation instructions, a review of the application method, customer approval and periodic field service representation during construction.
- 3. On access control installations, all wiring to be coordinated with a licensed electrical installer.
- B. Pre-Installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.
- 1.07 PROJECT CONDITIONS
 - A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.
- 1.08 WARRANTY
 - A. Provide under Provisions of Division 01 General Requirements.
 - B. Special Warranty: Provide 10-year Warranty under provisions of Division 01.
 - C. Warranty: Include coverage for complete System installation for failure to meet specified requirements.
 - 1. Failures include, but are not limited to the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Adhesive or cohesive sealant failures. Including perimeter sealant installation.
 - d. Air and Water leakage through fixed glazing and framing areas.
 - e. Failure of operating components to function properly.
 - D. Special Finish Warranty: Contractor agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
 - a. Warranty Period: 10 years for Anodized finishes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products of following manufacturers form basis for design and quality intended.
 - 1. Arcadia Inc., Vernon, CA. Basis-for-Design Manufacturer.
 - 2. Kawneer Company, Inc., Visalia, CA.
 - 3. EFCO Corporation, Monett, MO.
 - 4. Oldcastle Glass/Vistawall Architectural Products, Terrell, TX.
 - 5. Wausau Window and Wall Systems, Wausau, WI.
 - 6. Graham Architectural Products

- B. Or equal as approved in accordance with Division 01 General Requirements for Substitutions.
- 2.02 MATERIALS
 - A. Extruded Aluminum: ASTM B221; 6063-T6 alloy and temper
 - B. Glazing Gaskets: EPDM elastomeric extrusions
 - C. Spacers, Setting Blocks, Gaskets, and Bond Breakers: Manufacturer's standard permanent, non-migrating types in hardness recommended by manufacturer, compatible with sealants, and suitable for system performance requirements
 - D. Steel Reinforcement Sections: ASTM, A36; shapes to suit mullion sections, ASTM A611 for cold-rolled sheets.
 - E. Touch-Up Primer for Galvanized Surfaces: Zinc-rich Type.
 - F. Fasteners: Stainless steel.
 - G. Sealant: per Section 07 92 00 Joint Sealers.

2.03 FABRICATED COMPONENTS

- A. Frames: 2" x 4-1/2"to match existing.
 - 1. Model:
 - a. Arcadia AFG 451T (Thermal) Series, 2-1/4" x 4-1/2". Captured 2 sides, structural 2 sides
 - b. Or equal in accordance with Division 01, General Requirements
- 2.04 GLASS AND GLAZING MATERIALS
 - A. Tempered glass: All glazing shall be tested in accordance with CPSC 16 CFR 1201, and comply with the test criteria for Category II as indicated in Table 2406.2(1), 2016 CBC.
 - B. Glass in Exterior Lights and Doors: 1" thick insulating, tempered, tinted Low-E glass for TRIFAB VG 451T Thermal
 - C. Glass in Exterior Lights and Doors, 1/4" thick for TRIFAB VG 451, clear tinted tempered.
 - D. Glazing: All units shall be "dry" glazed with EPDM gasket on both exterior and interior.
- 2.05 HARDWARE DOORS
 - A. Refer to Section 08 71 00 Door Hardware
 - B. Weatherstripping:
 - 1. Meeting stiles on pairs of doors: adjustable astragal utilizing wool pile with polymeric fin.

- 2. Single acting door and frame: thermoplastic elastomer weathering on a tubular shape with a semi-rigid polymeric backing.
- Provide EPDM or vinyl-blade gasket weather-stripping in bottom of door rail, 3. adjustable for contact with threshold.

2.06 FABRICATION

- Fabricate doors and frames allowing for minimum clearances and shim spacing around Α. perimeter of assembly, yet enabling installation. Door corner construction shall consist of mechanical clip fastening, Shielded Inert Gas Metal Arc deep penetration plug welds and 1-1/8" long fillet welds inside and outside of all four corners.
- Β. Rigidly fit and secure joints and corners with internal reinforcement. Make joints and connections flush, hairline and weatherproof.
- C. Develop drainage holes with moisture pattern to exterior.
- D. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
- E. Prepare components to receive anchor devices. Fabricate anchorage items.
- F. Arrange fasteners, attachments and jointing to ensure concealment from view.
- G. Prepare components with internal reinforcement for door hardware and door operator hinge hardware.

2.07 FINISHES

- Extruded Aluminum Surfaces: Medium Bronze color anodized, AA-M10C22A44, Α. Class I. 0.7 mil. AAMA 611.
 - 1. Match existing adjacent finishes.
- Concealed Steel Items: Galvanized in accordance with ASTM A123 primed with Β. zinc-rich paint.
- Apply two coats of bituminous paint to concealed aluminum and steel surfaces in C. contact with cementitious or dissimilar materials.

SOURCE QUALITY CONTROL 2.08

- Source Quality: Provide aluminum entrances specified herein from a single source. Α.
- Fabrication Tolerances: Fabricate aluminum entrances in accordance with entrance Β. manufacturer's prescribed tolerances.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify wall openings and adjoining air and vapor seal materials are ready to receive Work of this Section.
- B. Beginning of installation means acceptance of existing conditions.
- 3.02 INSTALLATION
 - A. Install doors, frames, glazing and hardware in accordance with manufacturer's instructions. [Install door operator].
 - 1. Install doors and hardware in accordance with manufacturer's printed instructions.
 - 2. Set sill members in bed of sealant. Set other members with internal sealants and baffles to provide weather-tight construction.
 - B. Use anchorage devices to securely attach frame assembly to structure.
 - C. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent Work.
 - D. Coordinate attachment and seal of air and vapor barrier materials.
 - E. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
 - F. Install hardware using templates provided. Refer to Section 08 71 00 for installation requirements.
 - G. Install glass and infill panels in accordance with Section 08 80 00, using exterior manufacturer's standard extruded glazing gaskets [using structural glazing].
 - H. Install perimeter two component polyurethane type sealant, backing materials, and installation requirements in accordance with Section 07 92 00. Color shall match adjacent aluminum finish.
 - I. Adjust operating hardware.
 - J. Install Partition Closures at voids between glazing system and abutting walls, per manufacturer's recommendations.

3.03 TOLERANCES

- A. Variation from Plane: 0.03 inches per foot maximum or 0.25 inches per 30 feet, whichever is less.
- B. Misalignment of Two Adjoining Members Abutting in Plane: 0.015 inches.

3.04 ADUSTING

- A. Test door operating functions. Adjust closing and latching speeds and other hardware in accordance with manufacturer's instructions to ensure smooth operation.
- 3.05 CLEANING
 - A. Remove protective material from pre-finished aluminum surfaces.
 - B. Wash down exposed surfaces using a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
 - C. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes:
 - 1. Mechanical door hardware for:
 - a. Swinging doors.
- B. Exclusions: Unless specifically listed in hardware sets, hardware is not specified in this section for:
 - 1. Windows
 - 2. Cabinets (casework), including locks in cabinets

 - Signage
 Toilet accessories
 - 5. Overhead doors
- C. Related Sections:
 - 1. Division 01 Section "Alternates" for alternates affecting this section.
 - 2. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
 - 3. Division 09 sections for touchup finishing or refinishing of existing openings modified by this section.

1.03 REFERENCES

- A. UL Underwriters Laboratories
 - 1. UL 10B Fire Test of Door Assemblies
 - 2. UL 10C Positive Pressure Test of Fire Door Assemblies
 - 3. UL 1784 Air Leakage Tests of Door Assemblies
 - 4. UL 305 Panic Hardware
- B. DHI Door and Hardware Institute
 - 1. Sequence and Format for the Hardware Schedule

- 2. Recommended Locations for Builders Hardware
- 3. Key Systems and Nomenclature
- C. ANSI American National Standards Institute
 - 1. ANSI/BHMA A156.1 A156.29, and ANSI/BHMA A156.31 Standards for Hardware and Specialties
- D. 2016 State of California Building Code

1.04 REGULATORY REQUIREMENTS

- A. Locate latching hardware between 34 inches to 44 inches above the finished floor, per 2016 California Building Code, Section 11b-404.2.7.
 - 1. Panic Hardware: locate between 36 inches to 44 inches above the finished floor.
- B. Handles, pull, latches, locks, other operating devices:
 - 1. Readily openable from egress side without tight grasping, tight pinching, or twisting of the wrist to operate. 2016 California Building Code Section 11B-309.4.
 - 2. Force required to activate the operable parts: 5.0 pounds maximum, per 2016 California Building Code Section 11b-309.4.
- C. Adjust doors to open with not more than 5.0-pounds pressure to open at exterior doors and 5.0-pounds at interior doors. As allowed per 2016 California Building Code Section 11B-404.4.9, local authority may increase the allowable pressure for fire doors to achieve positive latching, but not to exceed 15-pounds.
- D. Low-energy powered doors: comply with ANSI/BHMA A156.19. Reference: 2016 California Building Code Section 11B-404.2.9, Exception 2.
 - 1. Where powered door serves an occupancy of 150 or more, provide back-up battery power or stand-by generator power, capable of supporting a minimum of 150 cycles.
 - Actuators, vertical bar type: minimum 2-inches wide, 30-inches high, bottom located minimum 5-inches above floor or ground, top located minimum 35-inches above floor or ground. Displays International Symbol of Accessibility, per 2016 California Building Code Section 11B-703.7.
 - 3. Actuators, plate type: use two at each side of the opening. Minimum 4-inches diameter or 4-inches square. Displays International Symbol of Accessibility, per 2016 California Building Code Section 11B-703.7. Locate centerline of lower plate between 7- and 8-inches above floor or ground, and upper plate between 30- and 44-inches above floor or ground.
 - 4. Actuator location: conspicuously located, clear and level floor/ground space for forward or parallel approach.
- E. Adjust door closer sweep periods so that from an open position of 90 degrees, the door will take at least 5 seconds to move to a point 12 degrees from the latch, measured to the landing side of the door, per 2016 California Building Code Section 11B-404.2.7.
 - 1. Spring hinges: adjust for 1.5 seconds minimum for 70 degrees to fully-closed.
- F. Smooth surfaces at bottom 10 inches of push sides of doors, facilitating push-open with wheelchair footrests, per 2016 California Building Code Section 11B-404.2.10.

- G. Door opening clear width no less than 32 inches, measured from face of frame stop, or edge of inactive leaf of pair of doors, to door face with door opened to 90 degrees. Hardware projection not a factor in clear width if located above 30 inches and below 80 inches, and the hardware projects no more than 4 inches. 2016 California Building Code Section 11b-404.2.3.
 - 1. Exception: doors not requiring full passage through the opening, that is, to spaces less than 24 inches in depth, may have the clear opening width reduced to 20 inches. Example: shallow closets.
 - 2. Door closers and overhead stops: not less than 78 inches above the finished floor or ground, per 2016 California Building Code 11B-307.4.
- H. Thresholds: floor or landing no more than 0.50 inches below the top of the threshold of the doorway per 2016 California Building Code Section 11B-404.2.5. Vertical rise no more than 0.25 inches, change in level between 0.25 inches and 0.50 inches: beveled to slope no greater than 1:2 (50 percent slope). 2016 California Building Code Section 11B-303.2-3.
- I. Floor stops: Do not locate in path of travel. Locate no more than 4 inches from walls, per DSA Policy #99-08 (Access).
- J. Pairs of doors: limit swing of inactive leaf to 90 degrees to protect persons reading wallmounted tactile signage. [Pairs of doors with independently-activated hardware both leafs: limit swing of right-hand or right-hand-reverse leaf to 90 degrees to protect persons reading wall-mounted tactile signage, per 2016 California Building Code Section 11B-703.4.2.]
- K. Door and door hardware encroachment: when door is swung fully-open into means-of-egress path, the door, including the hardware, may not encroach/project more than 7 inches into the required exit width. 2010 California Building Code 1005.2 and 1005.3. [2016 California Building Code, Section 1005.7.1.
 - 1. In I-2 occupancies, latch release hardware is not permitted to project in the required exit width, regardless of its mounting height.

1.05 SUBMITTALS

- A. General:
 - 1. Submit in accordance with Conditions of Contract and Division 01 requirements.
 - 2. Highlight, encircle, or otherwise specifically identify on submittals deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
 - 3. Prior to forwarding submittal, comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.
- B. Action Submittals:
 - 1. Product Data: Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
 - 2. Samples for Verification: If requested by Architect, submit production sample or sample installations of each type of exposed hardware unit in finish indicated, and tagged with full description for coordination with schedule.

- a. Samples will be returned to supplier in like-new condition. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
- 3. Door Hardware Schedule: Submit schedule with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Indicate complete designations of each item required for each door or opening, include:
 - a. Door Index; include door number, heading number, and Architects hardware set number.
 - b. Opening Lock Function Spreadsheet: List locking device and function for each opening.
 - c. Type, style, function, size, and finish of each hardware item.
 - d. Name and manufacturer of each item.
 - e. Fastenings and other pertinent information.
 - f. Location of each hardware set cross-referenced to indications on Drawings.
 - g. Explanation of all abbreviations, symbols, and codes contained in schedule.
 - h. Mounting locations for hardware.
 - i. Door and frame sizes and materials.
 - j. Name and phone number for local manufacturer's representative for each product.
- 4. Key Schedule:
 - a. After Keying Conference, provide keying schedule listing levels of keying as well as explanation of key system's function, key symbols used and door numbers controlled.
 - b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
 - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
 - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
 - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion.
 - 1) Forward bitting list, key cuts and key system schematic directly to Palomar Community College District, by means as directed by Palomar Community College District.
 - f. Prepare key schedule by or under supervision of supplier, detailing Palomar Community College District's final keying instructions for locks.
- 5. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory prepared for door hardware installation.
- C. Informational Submittals:
 - 1. Qualification Data: For Supplier and Installer.
 - 2. Certificates of Compliance:
 - a. Certificates of compliance for fire-rated hardware and installation instructions if requested by Architect or Authority Having Jurisdiction.
 - Installer Training Meeting Certification: Letter of compliance, signed by Contractor, attesting to completion of installer training meeting specified in "QUALITY ASSURANCE" article, herein.

- 3. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by qualified testing agency, for door hardware on doors located in accessible routes.
- 4. Warranty: Special warranty specified in this Section.
- D. Closeout Submittals:
 - 1. Operations and Maintenance Data : Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; 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.
 - e. Final approved hardware schedule, edited to reflect conditions as-installed.
 - f. Final keying schedule
 - g. Copies of floor plans with keying nomenclature
 - h. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
 - i. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

1.06 QUALITY ASSURANCE

- A. Product Substitutions: Comply with product requirements stated in Division 01 and as specified herein.
 - 1. Where specific manufacturer's product is named and accompanied by "No Substitute," including make or model number or other designation, provide product specified. (Note: Certain products have been selected for their unique characteristics and particular project suitability.)
 - a. Where no additional products or manufacturers are listed in product category, requirements for "No Substitute" govern product selection.
 - 2. Where products indicate "acceptable manufacturers" or "acceptable manufacturers and products", provide product from specified manufacturers, subject to compliance with specified requirements and "Single Source Responsibility" requirements stated herein.
- B. Supplier Qualifications and Responsibilities: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
- C. Installer Qualifications: Qualified tradesmen, skilled in application of commercial grade hardware with record of successful in-service performance for installing door hardware similar in quantity, type, and quality to that indicated for this Project.
- D. Fire-Rated Door Openings: Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to

authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

- E. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 - 1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
- F. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release latch. Locks do not require use of key, tool, or special knowledge for operation.
- G. Accessibility Requirements: For door hardware on doors in an accessible route, comply with governing accessibility regulations cited in "REFERENCES" article, herein.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of wrist and that operate with force of not more than 5 lbf (22.2 N).
 - 2. Maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
 - b. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
 - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - 3. Bevel raised thresholds with slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
 - 4. Adjust door closer sweep periods so that, from open position of 70 degrees, door will take at least 3 seconds to move to 3 inches (75 mm) from latch, measured to leading edge of door.
- H. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01.
 - 1. Attendees: Palomar Community College District, Contractor, Architect, Installer and Supplier.
 - 2. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - b. Preliminary key system schematic diagram.
 - c. Requirements for key control system.
 - d. Requirements for access control.
 - e. Address for delivery of keys.
- I. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Inspect and discuss preparatory work performed by other trades.
 - 3. Review required testing, inspecting, and certifying procedures.
- J. Coordination Conferences:

- 1. Installation Coordination Conference: Prior to hardware installation, schedule and hold meeting to review questions or concerns related to proper installation and adjustment of door hardware.
 - a. Attendees: Door hardware supplier, door hardware installer, Contractor.
 - b. After meeting, provide letter of compliance to Architect, indicating when meeting was held and who was in attendance.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
 - 1. Deliver each article of hardware in manufacturer's original packaging.
- C. Project Conditions:
 - 1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
 - 2. Provide secure lock-up for door hardware delivered to Project, but not yet installed. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- D. Protection and Damage:
 - 1. Promptly replace products damaged during shipping.
 - 2. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work.
 - 3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- E. Deliver keys to manufacturer of key control system for subsequent delivery to Palomar Community College District.
- F. Deliver keys and permanent cores to Palomar Community College District by registered mail or overnight package service.

1.08 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Palomar Community College District's security consultant.

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- D. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.
- E. Direct shipments not permitted, unless approved by Contractor.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Years from date of Substantial Completion, for durations indicated.
 - a. Closers:
 - 1) Mechanical: 30 years.
 - b. Locksets:
 - 1) Mechanical: 3 years for Schlage L Series Mortise
 - c. Key Blanks: Lifetime
 - 2. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The Palomar Community College District requires use of certain products for their unique characteristics and particular project suitability to insure continuity of existing and future performance and maintenance standards. After investigating available product offerings, the Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: "No Substitute."
 - 1. Where "No Substitute" is noted, submittals and substitution requests for other products will not be considered.
- B. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.
- C. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- D. Hand of Door: Drawings show direction of slide, swing, or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.

E. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

- A. Fasteners
 - 1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
 - 2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
 - 3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru-bolts are required.
 - 4. Install hardware with fasteners provided by hardware manufacturer.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
 - 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.03 HINGES

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product: Ives 3CB series
 - 2. Acceptable Manufacturers and Products: Hager AB series, McKinney TA series
- B. Requirements:
 - 1. Provide three-knuckle, ball bearing hinges conforming to ANSI/BHMA A156.1.
 - 2. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
 - a. Exterior: Standard weight, bronze or stainless-steel, 4-1/2 inches (114 mm) high
 - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
 - 3. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
 - a. Exterior: Heavy weight, bronze/stainless-steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
 - 4. 2 inches or thicker doors:
 - a. Exterior: Heavy weight, bronze or stainless-steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
 - 5. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.

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- 6. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
- 7. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless-steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins
- 8. Width of hinges: 4-1/2 inches (114 mm) at 1-3/4 inch (44 mm) thick doors, and 5 inches (127 mm) at 2 inches (51 mm) or thicker doors. Adjust hinge width as required for door, frame, and wall conditions to allow proper degree of opening.
- Doors 36 inches (914 mm) wide or less furnish hinges 4-1/2 inches (114 mm) high; doors greater than 36 inches (914 mm) wide furnish hinges 5 inches (127 mm) high, heavy weight or standard weight as specified.
- 10. Provide spring hinges where specified. Provide two spring hinges and one bearing hinge per door leaf for doors 90 inches (2286 mm) or less in height. Provide one additional bearing hinge for each 30 inches (762 mm) of additional door height.

2.04 CONTINUOUS HINGES

- A. Aluminum Geared
 - 1. Manufacturers:
 - a. Scheduled Manufacturer: lves.
 - b. Acceptable Manufacturers: No Substitute
 - 2. Requirements:
 - a. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
 - b. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum, with 0.25-inch (6 mm) diameter Teflon coated stainless-steel hinge pin.
 - c. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
 - d. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
 - e. On fire-rated doors, provide aluminum geared continuous hinges that are classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
 - f. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware.
 - g. Install hinges with fasteners supplied by manufacturer.
 - h. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

2.05 FLUSH BOLTS

A. Manufacturers:

- 1. Scheduled Manufacturer: Ives
- 2. Acceptable Manufacturers: No Substitute

B. Requirements:

 Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dustproof strikes at each bottom flush bolt.

2.06 COORDINATORS

- A. Manufacturers:
 - 1. Scheduled Manufacturer: Ives
 - 2. Acceptable Manufacturers: No Substitute
- B. Requirements:
 - 1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
 - 2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers and surface vertical rod exit device strikes. Factory-prep coordinators for vertical rod devices if required.

2.07

2.08 MORTISE LOCKS

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product: Schlage L9000 series
 - 2. Acceptable Manufacturers and Products: No Substitute
- B. Requirements:
 - Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1 Operational, Grade 1 Security, and manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
 - 2. Indicators: Where specified, provide indicator window measuring a minimum 2 inch x 1/2 inch with 180 degree visibility. Provide messages color-coded with full text and/or symbols, as scheduled, for easy visibility.
 - Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless-steel mechanical anti-friction latch-bolt. Provide deadbolt with full 1 inch (25 mm) throw, constructed of stainless-steel.
 - 4. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.

- a. UL Listed 3 hour fire door
- 5. Lever Trim: Solid brass, bronze, or stainless-steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
 - a. Lever Design: Schlage 06A.

2.09 EXIT DEVICES

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product: Von Duprin 98/35 series
 - 2. Acceptable Manufacturers and Products: No Substitute

B. Requirements:

- 1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1, and UL listed for Panic Exit or Fire Exit Hardware. Cylinders: Refer to "KEYING" article, herein.
- 2. Provide touchpad type exit devices, fabricated of brass, bronze, stainless-steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
- 3. Touchpad: Extend minimum of one half of door width. Match exit device finish, stainlesssteel for US26, US26D, US28, US32, and US32D finishes; and for all other finishes, provide compatible finish to exit device. No plastic inserts are allowed in touchpads.
- 4. Provide exit devices with dead-latching feature for security and for future addition of alarm kits and/or other electrified requirements.
- 5. Provide flush end caps for exit devices.
- 6. Provide exit devices with manufacturer's approved strikes.
- 7. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
- 8. Mount mechanism case flush on face of doors, or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
- 9. Provide cylinder dogging at non-fire-rated exit devices.
- 10. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
- 11. Where lever handles are specified as outside trim for exit devices, provide heavy-duty lever trims with forged or cast escutcheon plates. Provide vandal-resistant levers that will travel to 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.
 - a. Lever Style: Match lever style of locksets.
- 12. Provide UL labeled fire exit hardware for fire rated openings.
- 13. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
- 14. Provide electrified options as scheduled.

2.10 CYLINDERS

- A. Manufacturers:
 - 1. Scheduled Manufacturer: Schlage Primus

- 2. Acceptable Manufacturers: No Substitution
- B. Requirements:
 - Provide Full Size Interchangeable Core (FSIC) cylinders/cores to match Palomar Community College District's existing key system, compliant with ANSI/BHMA A156.5; latest revision, Section 12, Grade 1; permanent cylinders; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.
 - 2. Replaceable Construction Cores.
 - a. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
 - 1) 3 construction control keys
 - 2) 12 construction change (day) keys.
 - b. Palomar Community College District or Palomar Community College District's Representative will replace temporary construction cores with permanent cores.

2.11 KEYING

- A. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- B. Provide cylinders/cores keyed into Palomar Community College District's existing factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
 - 1. Contact Person: Dennis Astl at 760.744.1150 EXT 2772
 - 2. Contact Person: Mike Hill at 760.744.1150 EXT 2132
- C. Requirements:
 - 1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - a. Master Keying system as directed by the Palomar Community College District.
 - 2. Forward bitting list and keys separately from cylinders, by means as directed by Palomar Community College District. Failure to comply with forwarding requirements shall be cause for replacement of cylinders/cores involved at no additional cost to Palomar Community College District.
 - 3. Provide keys with the following features:
 - a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
 - 4. Identification:
 - a. Mark permanent cylinders/cores and keys with applicable blind code per DHI publication "Keying Systems and Nomenclature" for identification. Blind code marks shall not include actual key cuts.
 - b. Identification stamping provisions must be approved by the Architect and Palomar Community College District.
 - c. Stamp cylinders/cores and keys with Palomar Community College District's unique key system facility code as established by the manufacturer; key symbol and



embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.

- d. Failure to comply with stamping requirements shall be cause for replacement of keys involved at no additional cost to Palomar Community College District.
- e. Forward permanent cylinders/cores to Palomar Community College District, separately from keys, by means as directed by Palomar Community College District.
- 5. Quantity: Furnish in the following quantities.
 - a. Change (Day) Keys: 3 per cylinder/core.
 - b. Permanent Control Keys: 3.
 - c. Master Keys: 6.

2.12 DOOR CLOSERS

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product: LCN 4040XP series.
 - 2. Acceptable Manufacturers and Products: No Substitute.
- B. Requirements:
 - Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
 - 2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
 - 3. Cylinder Body: 1-1/2 inch (38 mm) diameter with 3/4 inch (19 mm) diameter double heattreated pinion journal.
 - 4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
 - 5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
 - 6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and back-check.
 - 7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
 - 8. Pressure Relief Valve (PRV) Technology: Not permitted.
 - 9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
 - 10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.13 DOOR CLOSERS

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product: LCN 1460 series
 - 2. Acceptable Manufacturers and Products: No Substitute
- B. Requirements:

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- 1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory.
- 2. Provide door closers with fully hydraulic, full rack and pinion action cylinder.
- 3. Closer Body: 1-1/4 inch (32 mm) diameter, with 5/8 inch (16 mm) diameter heat-treated pinion journal.
- 4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
- 5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
- 6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and back-check.
- 7. Pressure Relief Valve (PRV) Technology: not permitted.
- 8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.14 PROTECTION PLATES

- A. Manufacturers:
 - 1. Scheduled Manufacturer: Ives
 - 2. Acceptable Manufacturers: No Substitution
- B. Requirements:
 - 1. Provide kick plates, mop plates, and armor plates minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
 - 2. Sizes of plates:
 - a. Kick Plates: 10 inches (254 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
 - b. Mop Plates: 4 inches (102 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
 - c. Armor Plates: 36 inches (914 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs

2.15 DOOR STOPS AND HOLDERS

- A. Manufacturers:
 - 1. Scheduled Manufacturer: Ives
 - 2. Acceptable Manufacturers: No Substitution
- B. Provide door stops at each door leaf:
 - 1. Provide wall stops wherever possible. Provide convex type where mortise type locks are used and concave type where cylindrical type locks are used.
 - 2. Where a wall stop cannot be used, provide universal floor stops for low or high rise options.
 - 3. Where wall or floor stop cannot be used, provide medium duty surface mounted overhead stop.
2.16 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

- A. Manufacturers:
 - 1. Scheduled Manufacturer: Zero International
 - 2. Acceptable Manufacturers: No Substitution
- B. Requirements:
 - 1. Provide thresholds, weather-stripping (including door sweeps, seals, and astragals) and gasketing systems (including smoke, sound, and light) as specified and per architectural details. Match finish of other items.
 - 2. Size of thresholds:
 - a. Saddle Thresholds: 1/2 inch (13 mm) high by jamb width by door width
 - b. Bumper Seal Thresholds: 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width
 - 3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.

2.17 FINISHES

- A. Finish: BHMA 626/652 (US26D); except:
 - 1. Hinges at Exterior Doors: BHMA 630 (US32D)
 - 2. Continuous Hinges: BHMA 630 (US32D)
 - 3. Continuous Hinges: BHMA 628 (US28)
 - 4. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
 - 5. Protection Plates: BHMA 630 (US32D)
 - 6. Overhead Stops and Holders: BHMA 630 (US32D)
 - 7. Door Closers: Powder Coat to Match
 - 8. Wall Stops: BHMA 630 (US32D)
 - 9. Latch Protectors: BHMA 630 (US32D)
 - 10. Weatherstripping: Clear Anodized Aluminum
 - 11. Thresholds: Mill Finish Aluminum

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.

- 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
- 2. Custom Steel Doors and Frames: HMMA 831.
- 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- H. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as indicated in keying section.
 - 2. Furnish permanent cores to Palomar Community College District for installation.
- I. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- J. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Closers shall not be visible in corridors, lobbies and other public spaces unless approved by Architect.
- K. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- L. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- M. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- N. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.03 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to



operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

- 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, the Installer shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.04 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.05 DEMONSTRATION

A. Provide training for Palomar Community College District's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

3.06 DOOR HARDWARE SCHEDULE

- A. Locksets, exit devices, and other hardware items are referenced in the following hardware sets for series, type and function. Refer to the above-specifications for special features, options, cylinders/keying, and other requirements.
- B. Hardware Sets:

Hardware Set 1 - CARD ACCESSED HVAC LAB/EQUIPMENT YARD DOOR

Door(s):

505.2

Qty		Description	Catalog Number	Finish	Mfr
2	EA	CONT. HINGE	224XY TWP CON	628	IVE
1	EA	EU MORTISE LOCK	L9092TEU 06A RX DPS	630	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	SURFACE CLOSER	4040XP SHCUSH MC TBSRT	689	LCN
2	EA	KICK PLATE	8400 12" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
			(IF REQUIRED)		

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2	EA	DOOR SWEEP	39A	А	ZER
1	EA	MEETING STILE	43SP	SP	ZER
1	EA	THRESHOLD	103A-226	А	ZER
			(OR AS DETAILED)		
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	POWER SUPPLY	PS902	LGR	SCE
			(BY ACCESS CONTROL SYSTEM		
			PROVIDER)		
			ACCESS CONTROL - WORK OF		
			DIVISION 28		
			CARD READER - WORK OF DIVISION 28		
			DOOR CONTACT(S) - WORK OF		
			DIVISION 28		

Hardware Set 2 - CLASSROOM DOORS (45M)

Door(s):

404.1

Qty		Description	Catalog Number	Finish	Mfr
2	EA	CONT. HINGE	224XY	628	IVE
1	SET	AUTO FLUSH BOLT	FB32	630	IVE
1	EA	CLASSROOM	L9071T 06A L283-711	630	SCH
		SECURITY	[LESS INSIDE CYLINDER]		
1	EA	MORTISE CYL TURN	09-900 114 XB11-720	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	SURFACE CLOSER	1461 FC TBSRT	689	LCN
2	EA	KICK PLATE	8400 12" X 2" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CVX	630	IVE
			(REQUIRES WALL BACKING)		
2	EA	FIRE ASTRAGAL	383FSAA	AA	ZER
1	EA	GASKETING	188SBK PSA	BK	ZER

Hardware Set 3 - CLASSROOM DOORS W/PH (45M)

Door(s):

505.1

Qty		Description	Catalog Number	Finish	Mfr
2	EA	CONT. HINGE	224XY	628	IVE
1	EA	FIRE RATED	KR9954 STAB	689	VON
		REMOVABLE MULLION			
2	EA	FIRE EXIT HARDWARE	PA-AX-98-L-F-2-06	626	VON
2	EA	RIM CYLINDER	20-057 ICX	626	SCH
2	EA	PRIMUS CORE	20-740	626	SCH
2	EA	RIM CYL THUMBTURN	XB11-979	626	SCH

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2	EA	SURFACE CLOSER	4040XP EDA MC TBSRT	689	LCN
2	EA	KICK PLATE	8400 12" X 2" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CVX	630	IVE
			(REQUIRES WALL BACKING)		
2	EA	ANGLED ADB COVER	141AA	AA	ZER
2	EA	MEETING STILE	328AA-S	AA	ZER
2	EA	ACOUSTICAL AUTO	367AA	AA	ZER
		воттом			
1	EA	COVER PLATE	601CPA-NH	А	ZER
			(IF REQUIRED)		
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	MULLION SEAL	8780NBK PSA	BK	ZER

Hardware Set 4 - STORAGE ROOM DOORS (45M)

Door(s):

505B.1

Qty		Description	Catalog Number	Finish	Mfr
2	EA	CONT. HINGE	224XY	628	IVE
1	SET	AUTO FLUSH BOLT	FB32	630	IVE
1	EA	CLASSROOM	L9071T 06A L283-711	630	SCH
		SECURITY	[LESS INSIDE CYLINDER]		
1	EA	MORTISE CYL TURN	09-900 114 XB11-720	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	SURFACE CLOSER	4040XP SCUSH TBSRT	689	LCN
2	EA	KICK PLATE	8400 12" X 2" LDW B-CS	630	IVE
2	EA	FIRE ASTRAGAL	383FSAA	AA	ZER
1	EA	GASKETING	188SBK PSA	BK	ZER

Hardware Set 5 - LECTURE ROOM DOORS

Door(s):

505B.2

Qty		Description	Catalog Number	Finish	Mfr
2	EA	CONT. HINGE	224XY	628	IVE
1	EA	AUTO FLUSH BOLT	FB31T	630	IVE
1	EA	CLASSROOM	L9071T 06A L283-711	630	SCH
		SECURITY	[LESS INSIDE CYLINDER]		
1	EA	MORTISE CYL TURN	09-900 114 XB11-720	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	SURFACE CLOSER	4040XP SCUSH TBSRT	689	LCN
2	EA	KICK PLATE	8400 12" X 2" LDW B-CS	630	IVE

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1	EA	MEETING STILE	383AA	AA	ZER
1	EA	GASKETING	188SBK PSA	BK	ZER

Hardware Set 6 - LECTURE ROOM DOOR

Door(s):

504.1

Qty		Description	Catalog Number	Finish	Mfr
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	FIRE EXIT HARDWARE	PA-AX-98-L-F-2-06	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	RIM CYL THUMBTURN	XB11-979	626	SCH
1	EA	MOUNTING BRACKET	MB	689	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH TBSRT	689	LCN
1	EA	KICK PLATE	8400 12" X 2" LDW B-CS	630	IVE
1	EA	ANGLED ADB COVER	141AA	AA	ZER
1	EA	GASKETING	870AA-S	AA	ZER
1	EA	ACOUSTICAL AUTO	367AA	AA	ZER
		BOTTOM			
1	EA	COVER PLATE	601CPA-NH (IE REQUIRED)	А	ZER
1	EA	GASKETING	188SBK PSA	BK	ZER

Hardware Set 7 - OFFICE DOOR

Door(s):

505C.2

Mfr
IVE
SCH
SCH
IVE
ZER

Hardware Set 8 - OFFICE DOOR (45M)

Door(s): 505C.1

Qty	EA	Description	Catalog Number	Finish	Mfr
3		HINGE	3CB1 4.5 X 4.5	652	IVE
5015021-100		DOOR HAR	DWARE		
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1	EA	OFFICE W/SIM	L9056T 06A L583-363	630	SCH
		RETRACT			
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	SURFACE CLOSER	4040XP MC TBSRT	689	LCN
1	EA	FLOOR STOP	FS439	682	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	CLOTHES HOOK	543	630	IVE

Hardware Set 9 - EQUIPMENT YARD GATE

Door(s):

505D.1

Qty		Description	Catalog Number	Finish	Mfr
1	EA	PADLOCK L/CYL-FSIC	KS43D3200	606	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
			BALANCE OF HARDWARE BY GATE		
			MANUFACTURER		

Hardware Set 10 - AREA EXIT ONLY DOOR

Door(s):

ECH13.1

Qty		Description	Catalog Number	Finish	Mfr
1	EA	CONT. HINGE	224XY	313AN	IVE
1	EA	PANIC HARDWARE	PA-AX-98-EO	630	VON
1	EA	SURFACE CLOSER	4040XP EDA MC TBSRT	689	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA	689	LCN
1	EA	FLOOR STOP	FS18S	BLK	IVE
1	EA	DOOR SWEEP	39D	D	ZER
1	EA	THRESHOLD	103A-226 (OR AS DETAILED)	A	ZER
			DOOR CONTACT(S) - WORK OF		
			DIVISION 28		
			(IF REQUIRED)		
1	SET		PERIMETER SEAL BY FRAME MANUFACTURER		B/O

End of Section

SECTION 08 91 00

METAL WALL LOUVERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish and install louvers, structural supports and attachment brackets as shown on the drawings, as specified, and as needed for a complete and proper installation.
- B. Louvers and frames:1. Fixed Aluminum
- C. Insect Screening.
- D. Related Section1. Division 23 Heating Ventilating and Air Conditioning.

1.02 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. AMCA 500 (Air Movement and Control Association International) Test Method for Louvers, Dampers and Shutters.
- C. ASTM B 26 Aluminum-Alloy Sand Castings
- D. ASTM B 209 Aluminum and Aluminum-Alloy Sheet and Plate
- E. ASTM B 221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
- F. ASTM A 653 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

1.03 SYSTEM PERFORMANCE

- A. Structural Performance: Provide louvers capable of withstanding effects of gravity loads and stresses within limits without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.
- B. Seismic Performance: Provide louvers capable of withstanding effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 11, Seismic Criteria.

- C. Louver Performance (when a 4- by 4-foot louver is tested using AMCA Standard 500 and beginning of water penetration is 0.01-ozs-per-sq.ft free area) as indicated by the Louver Manufacturer.
- D. Thermal Movements: Provide louvers that allow for thermal movements resulting from following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 degrees Fambient; 180 degrees F, material surfaces, Air-Performance, Water-Penetration, Air-Leakage, and Wind-Driven Rain Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.04 SUBMITTALS

- A. Shop drawings showing, layout, elevations, dimensions, and tolerances; head, jamb, and sill details; blade configuration; screening and frames.
- B. Product data on pre-assembled louvers describing design characteristics, maximum recommended air velocity, free area, materials and finishes.
- C. Manufacturer's installation instructions.
- D. Three samples illustrating blade configuration, gauge of metal and screening.
- 1.05 QUALITY ASSURANCE
 - A. Manufacturer: Company specializing in manufacture of AMCA certified louvers with 5 years experience.
- PART 2 PRODUCTS
- 2.01 MANUFACTURERS
 - A. Products of following manufacturers form basis for design and quality intended.
 - 1. Airolite Co., Mariette, OH.
 - 2. Construction Specialties, San Marcos, CA.
 - 3. All-Lite Louvers, Fort Worth, TX.
 - 4. Ruskin Manufacturing, Kansas City, MO.
 - 5. Wonder Metals Corporation, Redding, CA.
 - 6. Greenheck Fan Corporation, Schofield, WI.
 - B. Or equal as approved in accordance with Division 01, General Requirements for Substitutions.

2.02 MATERIALS

- A. Basis of Design Product: Drainable Greenheck ESD 635 (minimum 50% free area), 6 inches deep, constructed of heavy gauge 6063-T5 aluminum, 6" x 0.081" nominal wall thickness. Blades constructed of heavy gauge extruded 6063-T5 Aluminum, 0.081" nominal wall thickness, positioned at 37 angles on approximately 4" centers.
 1. Dimensions: as indicated on drawings.
- B. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined
 - 1. Use types and sizes to suit unit installation conditions.

2.03 ACCESSORIES

materials.

- A. Insect Screen: 14 x 18, .011 aluminum mesh, set in aluminum frame, removable.
- B. Flashings and Closures: Of same material as louver frame.
- C. Sealants: As recommended by louver manufacturer.

2.04 FABRICATION

- A. Head, Jamb, and Sill Flashings: Roll formed to required shape, one piece per location.
- B. Screens: Install screen mesh in shaped frame with reinforced corner construction; screw to louver frame.
- 2.05 FINISHES
 - A. Prime and finish with Kynar 500 (PVDF) resin coating. Minimum 70% resin. AA-M12C42R1X, AAMA 2605.
 - B. Colors: as selected by Architect.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that prepared openings and flashings are ready to receive Work and opening dimensions are as indicated on shop drawings.
- B. Beginning of installation means acceptance of existing conditions.
- 3.02 INSTALLATION
 - A. Install louver assembly in accordance with manufacturer's instructions.
 - B. Install louvers level and plumb.

- C. Secure louvers in opening framing with concealed fasteners.
- D. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- E. Install perimeter sealant and backing rod in accordance with Section 07 92 00.
- 3.03 CLEANING
 - A. Clean surfaces and components.

END OF SECTION

SECTION 09 01 90

PREPARING EXISTING SURFACES FOR REFINISHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes preparing and repairing existing surfaces for painting or refinishing as indicated and scheduled. This work may include chemical de-glossing of lead-based paint and removal of mold or mildew infested materials.
- B. Related Sections
 - 1. Section 07 92 00, Joint Sealants
 - 2. Refer to drawings for Finish Schedule
 - 3. Section 09 29 00, Gypsum Wallboard
 - 4. Section 09 90 00, Painting

1.02 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. APCD Air Pollution Control District of San Diego County
 - 1. APCD-50 APCD Regulation IV, Rule 50, Visible Emissions
 - 2. APCD-67.0 APCD Regulation IV, Rule 67.0, Architectural Coatings
 - 3. APCD-67.21 APCD Regulation IV, Rule 67.21, Adhesive Material and Application Operations
- C. ASTM American Society for Testing and Materials
 - 1. ASTM D3359 Test Methods for Measuring Adhesion by Tape Test
 - 2. ASTM D4258 Surface Cleaning Concrete for Coating
 - 3. ASTM D4259 Practice for Abrading Concrete
- D. SSPC Steel Structures Painting Council, Surface Preparation (SP) Standards
 - 1. SSPC SP-1 Solvent Cleaning
 - 2. SSPC SP-2 Hand Tool Cleaning
 - 3. SSPC SP-3 Power Tool Cleaning
 - 4. SSPC SP-6 Commercial Blast Cleaning
- 1.03 SUBMITTALS
 - A. Action Submittals:
 - Product Data for each type of cleanser and accessory item a. VOC content
 - 2. Manufacturer's Installation Instructions
 - B. Record Submittals
 - 1. Statements of Qualifications from manufacturers
 - 2. Statement of Qualifications from applicator

- 3. Statements of Qualifications for workers assigned to de-gloss lead paint or removal and handling of mold/mildew infested materials
- 4. Certificates of Compliance regarding performance requirements
- 5. SWPPP Compliance Activity Logs
- 6. Construction IAQ Compliance Activity Logs
- 7. Waste Management Logs

1.04 QUALITY ASSURANCE

- A. Certification of Materials. With each delivery of materials, manufacturer shall certify that materials comply with requirements of this Section.
- B. Field Samples. Provide field samples of each type of cleaning, repair and surface preparation. Where process requires multiple steps, and as directed by Architect, construct one edge of Field Sample as cut-away view showing each step in process.
 - 1. Modify materials and methods of application, as needed to obtain Architect's approval.
 - 2. Document materials and methods used to obtain Architect's approval. Maintain at least one copy of this documentation at the Site while this work is progress.
 - 3. Maintain access to and protect Field Samples from damage while this work is in progress.
 - 4. Upon acceptance of related work, clean and touch-up Field Samples, as needed to permit painting or refinishing as scheduled.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in their original, unopened, and undamaged containers bearing manufacturers' labels, legible and intact.
 - 1. Open materials on premises in presence of the Inspector. Immediately remove rejected materials from premises. Obtain new complying materials without claim for change in Contract Sum or Schedule.
- B. Storage and Mixing of Materials. Store materials and mix only in spaces designated for this purpose by Inspector. Keep such spaces clean and take necessary precautions to prevent fire. Hang out oily rags, singly, in the open air. Stack containers so that manufacturer's labels are clearly displayed.
- C. Take necessary precautions to secure materials and equipment after the completion of each day's work to prevent damage, theft and vandalism.

PART 2 - PRODUCTS

- 2.01 MATERIALS
 - A. Cleansers, chemical de-glossers, and related materials shall comply with applicable requirements of the Food and Drug Administration's (FDA) Lead Law requirements of the California Air Resources Board (CARB), and the Environmental Protection Agency (EPA).
 - 1. Cleansers, chemical de-glossers, and related materials shall be suitable for the use intended and compatible with the finish scheduled.

- B. Mildewcide: commercially prepared fungicide, biocide, or anti-microbial agent suitable for killing mold and mildew and scrubbing surface manifestations of infestation from material.
- C. Sealants: as specified in Section 07 92 00. Furnish with primers, joint fillers, backer-rods, and related accessories as recommended by sealant manufacturer for each condition.
- D. Elastomeric Finish: subject to confirmation of compatibility with finish scheduled in Sections 09 06 00 and 09 90 00.
 - 1. Primer: Sherwin Williams, W709, or equal.
 - 2. Finish: Sherwin Williams, W370, or equal.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine surfaces to be repaired and prepared.
 - 1. Determine, by field testing, whether scheduled finishes are compatible with existing coatings to ensure proper adhesion.
 - 2. For field test, apply a Finish Sample of scheduled finish over approxiamately 1/2 of Surface Prep Field Sample. Finish Sample shall be at least 3-feet square; allow Sample to dry for 1 week. Test adhesion using ASTM D3359.
- B. Do not begin installation until unsatisfactory conditions are corrected. Beginning installation means acceptance of existing conditions and preparatory work of others.

3.02 PROTECTION

- A. Protect work of other trades and existing adjacent surfaces or areas, whether to be coated or not, against damage from this work. Correct damage by cleaning, repairing, replacing and recoating as acceptable to the Inspector. Leave in an undamaged condition.
- B. Provide sufficient drop cloths, shields, and protective equipment to prevent spray, over-spray or droppings from fouling surfaces, furniture, equipment, cabinets, etc.
- C. Protect prefinished surfaces, lawns, shrubbery, and adjacent surfaces against damage.
- D. Protect surfaces, equipment and fixtures from damage resulting from use of fixed, movable and hanging scaffolding, planking and staging.
- E. Place waste materials, cloths, and material that may constitute a fire hazard in closed metal containers and remove daily from the site.
- F. Remove electrical plates, surface hardware, fittings and fastenings, prior to preparation operations. Inventory and mark for storage. Do not use solvents, which may remove permanent lacquer finish, to clean hardware or other items.

- G. Provide signs, barricades and other devices required to protect newly prepared surfaces.
- H. After each day's work, take precautions to secure equipment and supplies to prevent damage, theft, and vandalism due to access by unauthorized persons.

3.03 PREPARATION OF EXISTING PAINTED SURFACES - GENERAL

- A. Assign experienced workers, skilled in their trades to this work. Surface preparation shall comply with standards of the Painting and Decorating Contractors of America.
- B. Prepare ceilings, then walls.
- C. Remove posters, art work, and appliquéés, remove residual adhesive, fill tack and nail holes, and clean as specified in this Section.
- D. Remove surface contaminants such as oils, grease, loose paint, cracking, blistering, peeling, or flaking paint, dirt, foreign matter, rust, and other surface contaminants that will interfere with adhesion of scheduled finish, without damaging the substrates and adjacent areas; use methods referenced in ASTM D4258. Let dry thoroughly, lightly sand surfaces.
- E. Remove substrate materials infested with mold or mildew. Extend removal in all directions from infested site to nearest natural break or support that will facilitate patch and repair. Handle and discard removed materials as hazardous waste. Haul debris, off-site, to disposal facility legally franchised to accept such materials.
- F. In existing rooms and areas where alterations occur, clean existing transparent wood finishes. Retouch abraded surfaces and apply 1 coat of polyurethane varnish to exposed surfaces.
- G. Coat knots and pitch streaks that show through old finish with knot sealer before refinishing.
- 3.04 PREPARATION OF INTERIOR SURFACES PAINT
 - A. Wood, Plaster, and Metal Surfaces, with sound, low sheen, finish coating. Strip and completely remove wax, if any, before washing. Wash with TSP (trisodium phosphate), to remove dirt, grease and other foreign materials, rinse with clean water and then sand and dust off.
 - B. Wood, Plaster, and Metal Surfaces, with checked, cracked, blistered, scaled, loose, and alligatored paint. Removed defective finish down to bare substrate with hand-tools, chemical stripper, or both, hand sand, and dust clean. Wash remaining sound finish as above. Feather the edges of paint removal into the existing finishes to remain to maintain proper and uniform finish.
 - C. Wood Doors and Cabinet Work scheduled for reapplication of transparent finishes. Strip existing finish, sand surfaces thoroughly with a 5/0, 180 grit, sandpaper and dust clean.

- D. Gypsum Board. Remove contamination from surfaces and prime to show defects, if any. Fill defects in surfaces flush with adjacent surfaces. Feather edges of patch into the existing adjacent surface. Repair cracks, holes, gouges, and damaged spots larger than 1/4-inch, as specified in Section 09 29 00.
- E. Concrete and Unit Masonry Surfaces. Remove dirt, salt- or alkali-residue, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering or corroding metals by thoroughly wetting with water and washing with a solution of sodium metasilicate. Allow to dry.
- F. Existing glossy paint films must be cleaned and dulled (de-glossed) before repainting. Wash thoroughly as specified and dull by sanding.
- 3.05 PREPARATION OF EXTERIOR SURFACES WHERE EXISTING COATING IS COMPATIBLE WITH SCHEDULED NEW FINISH
 - A. Examine surfaces for cracking, blistering, peeling or flaking of existing paint. Remove loose, unsound, and non-adhering paint, feather edge at transitions. Repair existing surfaces and prepare surfaces for new finishes as scheduled in Sections 09 06 00 and 09 90 00. Lightly sand surfaces prior to painting.
 - 1. Remove surface contaminants such as oils, grease, loose paint, dirt, foreign matter, rust, mold, mildew, efflorescence, and other surface contaminants that will interfere with adhesion of subsequent coats without damaging the substrates or adjacent areas by methods referenced in ASTM D4258.
 - 2. Glossy surfaces of existing paint films must be cleaned and washed thoroughly as specified and dull by sanding before painting. Degloss glossy and previously enameled surfaces by sanding or abrasive cleanser to provide a roughened surface or "tooth" for proper adhesion of scheduled finish.
- 3.06 PREPARATION OF EXTERIOR SURFACES WHERE EXISTING COATING IS NOT COMPATIBLE WITH SCHEDULED NEW FINISH
 - A. Remove entire existing coating by blast cleaning per one of the following ASTM D4259 methods. Use method that removes coatings completely.
 - 1. Dry sand-blast lightly using 16- to 30-mesh sand and oil-free air sprayer. Hold nozzle approximately 2 feet from the surface to be blasted move nozzle at a uniform rate. Surface must be clean and dry and exhibit texture similar to that of medium grit sandpaper. Vacuum or blow down to remove dust and loose particles from the surface.
 - 2. Water blasting with pressure at 2500 psi at flow of 4 to 14 gallons per minute.
- 3.07 REPAIRING CRACKS AT INTERIOR PLASTER AND CONCRETE SURFACES
 - A. Hairline Cracks: V-groove cracks then patch with elastomeric sealant, as specified in Section 07 92 00.

- B. Small to Large Cracks: Use elastomeric sealant to fill and span cracks up to 1/32-inch. A credit card thickness or greater (1/8"), fill with an elastomeric sealant (recommended by the Paint Manufacturer). Apply one coat of primer, then coat with 100-percent acrylic, elastomeric finish.
- C. Large Cracks (1/4- to 1/2-inch). Rake to 1/4-inch minimum wide, then fill with an elastomeric sealant.
 - 1. Apply 1 coat of primer, then coat with 100-percent acrylic, elastomeric finish.
 - 2. Apply a primer coat over the elastomeric coating to change absorbency to be similar to adjacent wall surface. elastomeric sealant shall be compatible with paint applications used and manufacturer's recommendations.
- 3.08 REPAIRING CRACKS AT exterior PLASTER AND CONCRETE SURFACES
 - A. Hairline Cracks: Apply 2 coats of elastomeric coating to bridge hairline cracks to 1/32"
 - B. Small to Large Cracks: from 1/32" to 1/8" fill with an elastomeric sealant, apply 2 coats of elastomeric coating.
 - C. Large Cracks: cracks from 1/4" to 1/2", raked out crack(s) to 1/4" minimum wide, fill with an elastomeric sealant, apply 2 coats of elastomeric coating.
 - D. All elastomeric sealant shall be compatible with paint applications used and manufacturer'¢s recommendations.
 - E. Apply a primer coat over the elastomeric coating to change absorbency to be similar to adjacent wall surface.
 - F. Finish Coat: apply final application of finish coat over patched areas to match existing adjacent texture. Use an integral-color finish stucco material with a bonding admixture mixed according to manufacturer's recommendation.
 - G. Efflorescence: repair surfaces and remove deposits by wire brushing and acid etching with phosphoric acid. Rinse surfaces with water to remove any remaining residue. Prior to proceeding with any painting of these surfaces obtain the approval of the Architect and Inspector.
- 3.09 CLEANING, TOUCH-UP AND REFINISHING
 - A. As work proceeds and upon completion, promptly remove paint where spilled, splashed, or spattered.
 - B. During progress of work keep premises free from any unnecessary accumulation of tools, equipment, surplus materials, and debris.
 - C. Upon completion of work remove rubbish, paint cans and accumulated materials resulting from work in each space or room. areas shall be left in a clean, orderly condition to the satisfaction of the Owner.

- D. Upon completion of painting, clean glass and paint spattered surfaces. Remove spattered paint by washing, scrapping or other professional methods using care not to scratch or damage adjacent finished surfaces.
- E. Protect completed work until Date of Substantial Completion.

END OF SECTION

SECTION 09 05 61

COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the furnishing, testing, and application of systems for the reduction of moisture vapor transmission and alkalinity control for all interior concrete slabs scheduled to receive adhered floor coverings.
- B. Related Sections: Coordinate work of this Section with work of other Sections to properly execute the work requirements and maintain satisfactory progress of work in other Sections.
 - 1. Section 03 30 00 Cast-In Place Concrete.
 - 2. Division 09 Sections for adhered floor coverings.

1.02 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. ASTM International
 - 1. F 710 Preparing Concrete Floors to Receive Resilient Flooring
 - 2. F 1869 Measuring Moisture Vapor Emission Rate of Concrete Subfloor
 - 3. F 2170 Relative Humidity in Concrete Floor Slabs Using in situ Probes
 - 4. F 2420 Relative Humidity on the Surface of Concrete Floor Slabs
- C. AQMD Air Quality Management District
 - 1. SCAQMD South Coast Air Quality Management District, Rule 1113 Architectural Coatings
- 1.03 SCHEDULING
 - A. Coordinate scheduling of all pre-application testing, application, and post-application testing to allow adequate slab curing and acclimatization prior to testing, and adequate time for curing of the treatment before final testing and installation of floor coverings.
- 1.04 SUBMITTALS
 - A. Product Data: For each type of product and process proposed
 - B. Test and Evaluation Reports
 - C. Manufacturer's Instructions: For installation
 - D. Qualification Statements: For manufacturer and installer
 - E. Closeout Submittals

1. Warranty Documentation

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Manufacturer shall have no less than ten (10) years experience in manufacturing water vapor reduction systems. The water vapor reduction system must be specifically formulated and marketed for water vapor reduction and alkalinity control without change of system design for a minimum period of five (5) years.
- B. Applicator's Qualifications: Currently approved by the manufacturer, experienced in surface preparation and application of the material and subject to inspection of the manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the job site in their original unopened containers, clearly labeled with the manufacturer's name and brand designation.
- B. Store products in an approved ventilated dry area; protect from dampness, freezing, and direct sun light. Product should not be stored in areas with temperatures in excess of 90° F or below 50° F.
- C. Handle product in a manner that will prevent breakage of containers and damage products.

1.07 FIELD CONDITIONS

- A. Environmental Conditions
 - 1. Do not apply moisture vapor reduction system to surfaces that may be exposed to excessive weather conditions (such as rain, wind, etc) until the material has fully cured, or when water is accumulated on the surface of the concrete. Protect freshly applied coating accordingly when material is applied outdoors.
 - 2. Do not apply water vapor reduction system when temperature is lower than 50°F or expected to fall below this temperature within 24 hours from time of application.

1.08 WARRANTY

- A. Manufacturer shall warrant system to maintain moisture vapor emission rate, relative humidity, and pH within specified limits for not less than ten (10) years from the date of Certified Completion.
- B. Manufacturer's warranty shall include all materials and labor to repair or replace concrete slab, damaged floor coverings, and any other construction or Owner's property damaged due to slab failure or resultant mold growth.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products of the following manufacturer form the basis of design and quality intended for the Project:
 - 1. KÓSTER American Corporation, Virginia Beach, VA.
- B. Subject to compliance with requirements, other acceptable manufacturers include, but are not limited to, the following:
 - 1. Ardex Engineered Cements, Aliquippa, PA.
 - 2. Bostik Inc, Wauwatosa, WI.
 - 3. CHEMREX div of BASF Construction Chemicals, Shakopee, MN.
 - 4. Düraamen Engineered Products Inc, New York, NY.
 - 5. MAPEI Americas, Deerfield Beach, FL.
 - 6. Maxxon Corporation, Hamel, MN.
 - 7. Miracote div of Crossfield Products Corp, Rancho Dominguez, CA.
 - 8. ProSpec div of Bonsal American Inc, Charlotte, NC.
 - 9. Aquafin, Inc., Elkton, MD.
- C. Or equal, as approved in accordance with Division 01 requirements for Substitutions.

2.02 DESCRIPTION

- A. Basis-of-Design: KÓSTER VAP I[®] 2000 System.
- 2.03 PERFORMANCE CRITERIA
 - A. Installed system shall reduce water vapor transmission levels to 3 lbs/1000 ft²/24 hr or less, relative humidity to 75% or less, and pH to between 7.0 and 8.0.
 - B. Products shall comply with SCAQMD Rule 1168 VOC limit of 100 g/L.

2.04 MATERIALS

- A. 100% solids epoxy coating, containing specifically formulated chemicals and resins to provide the specified criteria in a one coat system. No multi-coat systems are allowed. System must contain 100% solid epoxy system.
- B. Primers, concrete repair materials, and other accessory products as recommended by moisture vapor reduction treatment manufacturer.
 - 1. Primer: Koster VAP I 06 Primer
 - 2. Cementitious Underlayment: Koster SL Standard

PART 3 - EXECUTION

3.01 GENERAL

- A. All new and existing concrete slabs, including slabs-on-grade and suspended slabs, that are scheduled to receive adhered floor coverings, shall be treated regardless of test results; pre-treatment testing is for the manufacturer's and applicator's use in determining the necessary coverage rate.
 - 1. Slab areas not requiring testing or treatment include areas scheduled for the following flooring types:
 - a. Sealed exposed concrete.
 - b. Polished or dyed and polished concrete.
 - c. Depressed slabs to receive mortar-bed tiling.
- B. If pre-application test results indicate variations in the slab conditions among different areas, the coverage rate for the entire slab shall be determined based on the highest moisture area.

3.02 EXAMINATION OF SUBSTRATE BEFORE APPLICATION

- A. Calcium Chloride and RH Probe test requirements:
 - 1. Provide anhydrous calcium chloride tests according ASTM F 1869 protocols.
 - a. Only conduct calcium chloride tests at the same temperature and humidity expected during normal use. If this is not possible, then the test conditions should be 75°F +/-10°F and 50% (+/-10%) relative humidity. Maintain these conditions 48 hours prior to and during testing. Water vapor transmission levels are directly affected by ambient room temperature and readings conducted without a sustained ambient temperature are NOT acceptable.
 - 2. Provide RH Probe Tests according to ASTM F 2170 protocols.
 - 3. Provide test results with a marked-up floor finish plan showing test results. Provide a written clarification on status of the ambient air temperature and humidity before and during the testing procedures.
- B. Test for concrete deficiencies and contaminates such as un-reacted water-soluble silicates, chlorides, A.S.R. (alkali-silica reaction), oil contamination, etc. This testing should be performed using standard coring methods. Also, the history of the slab installation should be reviewed. Concrete should conform to ACI Committee 201 Report "Guide to Durable Concrete."

3.03 PREPARATION

A. Inspect all surfaces with regard to their suitability to receive moisture vapor reduction system with manufacturer's representative.

- B. Clean all surfaces to receive moisture vapor reduction system. Shot blast all floors to a Concrete Surface Profile (CSP) #3 or #4 and clean surfaces with an industrial vacuum cleaner and remove all residues from the substrate. Grinding is allowed only in areas not accessible by shot blasting. Remove ALL defective materials, and foreign matter such as dust, adhesives, leveling compounds, paint, dirt, floor hardeners, bond breakers, oil, grease, curing agents, form release agents, efflorescence, laitance, shot blast beads, etc. Repair all cracks, expansion joints, control joints, and open surface honeycombs and fill in accordance with Manufacturer's recommendations. If concrete additives such as chlorides or any other water-soluble compounds that may contaminate surfaces have been used in the concrete mix do not use this product on that floor without written approval from moisture vapor reducing treatment manufacturer. Reinforcing fibers that are visible after shot blasting must be removed and vacuumed leaving no fibers left on the concrete surfaces. Provide an uncontaminated, sound surface. DO NOT ACID ETCH!
- C. Repair concrete prior to moisture vapor reduction system installation with approved concrete repair materials. Comply with all requirements as listed in Manufacturer's technical data information. Consult with vapor reduction manufacturer.
- D. Ensure surfaces to be treated with moisture vapor reduction system have NOT previously been treated with other materials such as underlayments, screeds, penetrating sealants, silicates, etc. If this is the case, consult with the Manufacturer's Representative prior to any application of moisture vapor reduction system.
- E. Shot blast a small test area and review surface profile with the finished flooring applicator. As the moisture vapor reduction treatment is not a leveling material, make sure the flooring installer is aware that a feather finish or leveling material may be required to smoothen or level the surface of the treated concrete prior to the flooring installation.
- 3.04 MIXING
 - A. Use clean containers and mix thoroughly as per Manufacturer's requirements to obtain a homogeneous mixture. Use a low speed motor less than 400 rpm and a two bladed Jiffy-type mixing blade only. DO NOT AERATE. Mix ratios are measured by volume.

3.05 APPLICATION

- A. Determine the necessary coverage rate based on the surface profile and porosity of the concrete substrate as well as the measured level of moisture, in accordance with manufacturer's requirements.
- B. After mixing, pour material on the substrate in a ribbon. Empty can completely.
- C. Spread material using a squeegee and back-roll with a 3/8 inch nap epoxy-rated roller leaving NO areas untreated.
- D. Allow to cure a minimum of 12 hours before installing flooring system.

- E. After shot blasting and installation of the vapor reduction system, a self-leveling cementitious underlayment system or patching compound shall be applied for the floor covering installer or floor covering manufacturer to smoothen or level surfaces, at no extra cost to the Owner. Never apply moisture vapor reduction treatment over any new or existing cementitious underlayment system unless approved in writing by the manufacturer.
- F. When water based adhesives are used in the floor covering installation, use an approved underlayment system together with a non-porous substrate primer prior to the installation of the flooring system, at no extra cost to the Owner. Consult the adhesive manufacturer for their minimum recommended thickness of cementitious underlayment to absorb excess moisture in the adhesive, minimum 1/8" thickness.

3.06 FIELD QUALITY CONTROL

- A. Post-installation testing shall be by IOR or Owner's Testing Laboratory.
- B. Perform ASTM F 710 pH, F 1869, and F 2420 tests after curing of the vapor reduction treatment.
- C. Verify proper adhesion of flooring adhesives, coatings, and leveling compounds to the final vapor reduction coating system for acceptability.
- D. Contractor shall correct any deficiencies identified by Testing Laboratory prior to delivery and installation of flooring materials.

3.07 PROTECTION

- A. Protect water vapor reduction system to prevent damage from active rain or topical water for a minimum period of 24 hours from time of application.
- B. Protect each coat during specified cure period from any kind of traffic, topical water and contaminants.

END OF SECTION

SECTION 09 24 00

PORTLAND CEMENT PLASTER

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Portland cement plaster system with acrylic finish
 - B. Metal furring and lathing
 - C. Related Section
 - 1. Section 05 40 00, Cold Formed Metal Framing
 - 2. Refer to drawings for Finish Schedule
 - 3. Section 09 29 00, Gypsum Board
 - 4. Section 09 90 00, Painting

1.02 SYSTEM DESCRIPTION

- A. Portland Cement Plaster: 7/8 inch thick, 3 coat system with a texture and paint finish.
 - 1. Scratch coat: 3/8-inch thick
 - 2. Brown coat: 3/8-inch thick
 - 3. Finish texture coat: 1/8-inch thick, integral color plaster free of tool marks and patterns
 - 4. Finish color coat: paint finish as specified in Section 09 90 00
 - a. Colors: as scheduled in Section 09 06 00

1.03 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A653 Galvanized Sheet Steel
 - 2. ASTM C150 Portland Cement
 - 3. ASTM C206 Finishing for Hydrated Lime
 - 4. ASTM C847 Standard Specification for Metal Lath
 - 5. ASTM C897 Aggregate for Job-Mixed Portland Cement Based Plasters
 - 6. ASTM C926 Application of Portland Cement-Based Plaster
 - 7. ASTM C932 Bonding Compounds for Exterior Plastering
 - 8. ASTM C954 Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033-inch to 0.112-inch in Thickness
 - 9. ASTM C1063 Installation of Lathing and Furring for Portland cement Based Plaster
- C. AATCC American Association of Textile Chemists and Colorists
 - 1. AATCC 127 Water Resistance: Hydrostatic Pressure Test

- D. ACI 524R American Concrete Institute, Guide to Portland Cement Plaster, for Reference for Repair of cement plaster
- E. CCR Title 24, 2016 California Building Code
 1. CBC-25 Chapter 25, Gypsum Board and Plaster
- 1.04 SUBMITTALS
 - A. Product Data: for each type of product indicated.
- 1.05 QUALITY ASSURANCE
 - A. Applicator: company with at least 5-years experience in cement plaster work for commercial projects similar in scale and complexity to those required for this Project.
 - B. Cement plaster work shall comply with 2016 California Building Code.
 - 1. Two-Coat Plaster system (base and finish) not permitted.
 - C. Mockups: Prior to installing plaster work, construct panels for each type of finish and application required to verify selections and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with following requirements, using materials indicated for final unit of Work.
 - 1. Locate mockups on-site in location and of size indicated or, if not indicated, as directed by Architect.
 - 2. Erect mockups 48 by 48-inchesby full thickness in presence of Architect using materials, including lath, support system, and control joints, indicated for final Work.
 - 3. Notify Architect 7 days in advance of dates and times when mockups will be constructed.
 - 4. Demonstrate proposed range of aesthetic effects and workmanship.
 - 5. Obtain Architect's approval of mockups before start of plaster Work.
 - 6. Retain and maintain mockups during construction in an undisturbed condition as standard for judging completed portland cement plaster Work.
 - a. When directed, remove mockups from Project site.

1.06 DELIVERY AND STORAGE

- A. Deliver products in unbroken containers or bundles with manufacturer's labels intact and legible.
- B. Store products in dry location.
- 1.07 ENVIRONMENTAL REQUIREMENTS
 - A. Comply with ASTM C 926 requirements.
 - B. Exterior Plasterwork
 - 1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.

- 2. Do not apply plaster during wet weather, or when wet weather conditions can be forecast reasonably or during periods of high winds.
- 3. Do not apply stucco when the ambient temperature is 40 degrees F or lower, or when a drop in temperature below 40 degrees F is expected within 48 hours after application, unless the work area is enclosed and heat is provided as follows:
 - a. When artificial heat is required, heaters shall be located to prevent a concentration of heat on uncured plaster. Heaters shall be vented to the outside to prevent toxic fumes and other products of combustion from adhering to or penetrating plaster bases and plaster. Adequate ventilation shall be maintained in all areas, particularly in interior areas with little or no natural air movement.
- 4. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
- C. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

PART 2 - PRODUCTS

- 2.01 PLASTER BASE COAT MATERIALS
 - A. Cement: Low alkali Portland Cement, ASTM C150, Normal, Type I or II. White color for finish coats.
 - B. Lime: ASTM C206 or ASTM C207, Type S
 - C. Aggregate: Natural or manufactured sand conforming to ASTM C897.
 - 1. For Scratch and Brown coats use sand graded as follows
 - a. <u>Sieve Size Percent Retained</u>
 - 1) No. 4 0
 - 2) No. 8 0 to 10
 - 3) No. 16 10 to 40
 - 4) No. 30 30 to 65
 - 5) No. 50 70 to 90 (60 to 80, manuf. sand)
 - 6) No. 100 95 to 100 (75 to 90, manuf. sand)
 - 7) No. 200 97 to 100 (90 to 100, Manuf. sand)
 - D. Water: clear, fresh, from a potable source, and free of mineral or organic matter that would adversely affect plaster.
 - E. Plasticizers: Only approved plasticity agents and approved amounts thereof may be added to portland cement. Hydrated lime or equivalent amount of lime putty used as plasticizer may be added to portland cement plaster not to exceed limits set forth in ASTM C 926, 2016 California Building Code.
- 2.02 PLASTER FINISH COAT MATERIALS
 - A. Premixed Finishing Coat: EXTERIOR COLOR COAT, manufactured by La Habra Stucco, Anaheim, CA, Merlex Stucco Inc., Highland Stucco Inc., Omega Products International color as selected from manufacturer's standard list, or equal as approved in accordance with Division 01, General Requirements for substitutions.

- 1. Custom colors as selected by Architect to match painting schedule.
- B. Factory-mixed Acrylic-based Finish Coatings: acrylic-emulsion coating system formulated with colorfast mineral pigments and fine aggregates: for use over Portland cement plaster base coats. Include manufacturer's primers and sealing topcoats for acrylic-based finishes. By STO, Sonneborn, Dryvit, Parex Inc. ParexLaHabra, Inc.; Acrylic Finish: Perma-Flex Stucco Grade or equal. For aggregates comparable to STO Stolit 0.75 apply finish in two coats. For aggregate comparable to STO Stolit 1.0, single coat application is acceptable. Include manufacturer's recommended primer.
 - 1. Finish Texture: fine sand [spray smooth] [coarse sand].
 - 2. Finish Color: as scheduled in Section 09 06 00.
 - 3. Primer: ParexUSA Primer or equal.
- C. Fog Coating: spray-applied, integral-color, Portland-cement finish that cures to become an integral part of the applied stucco. Install where Architect requires to smooth out color and texture.
 - 1. Color: match Finish Coat of stucco system
 - 2. Acceptable Product: FogCoat by La Habra Stucco, or equal, by stucco materials manufacturer.
- D. Water: clear, fresh, from a potable source, and free of mineral or organic matter that would adversely affect plaster.

2.03 FURRING AND LATHING

- A. At Exterior Walls, Two Types Permitted:
 - 1. Welded Wire Paper-Backed Lath: STUCCO-RITE 60 Min., zinc coated galvanized, 16 by 16-gage, 2-inch mesh, weight 1.84 pounds per square yard, with Type 1, Style 1, Grade D, building paper, FS UU-B-790A. Manufactured by K-Lath, Fontana, CA, or equal as approved in accordance with Division 01, General Requirements for substitutions.
 - a. Required: Heavy duty version with 11-gage stiffeners at 6-inches on centers.
 - b. Screws required at rigid backing, including plywood exterior or gypsum sheathing.
 - 2. Expanded metal Lath: ASTM C 847, Diamond mesh expanded metal lath, galvanized ASTM A653 G60, weighing 3.4 pounds per square yard, continuous "grooved" self-furred metal lath. Water-resistive barrier, FS UU-B-790a, Type 1, Style 1, Grade D, by ClarkDietrich Building Systems Riverside, CA. or equal.
 - 3. CommercialWrap D Weather Resistive Barrier by Tyvek, Typar or equal behind metal lath.
 - 4. Woven wire fabric (netting) not permitted.
- B. Manufacturers for Accessories
 - 1. ClarkDietrich Building Systems, Riverside, CA
 - 2. Fry Reglet Company, Alhambra, CA
 - 3. Flannery, Inc., San Fernando, CA.
 - 4. Or equal, approved in accordance with Division 01, General Requirements, for substitutions.

- C. At exterior walls with plywood or rigid backing fur out lath with screws, per ASTM C1063.
- D. Self-Adhered Flashing: 40 mils, nominal, thickness composite sheet, fabricated with nominal min. 4-mil polyethylene film and 32-mil rubberized asphalt.
 - 1. Acceptable Products: as follows, or equal, approved in accordance with Division 01, General Requirements, for substitutions.
 - a. Perm-A-Barrier Wall Flashing by W.R. Grace Co., Cambridge, MA.
 - b. CCW-705T-WF by Carlisle Coatings and Waterproofing.
 - c. Henry Company, Blueskin SA
 - d. FortiFlash 40 Recessed Window Flashing by Fortifiber.
 - e. Tyvek Flashing.
 - 2. Furnish with prefabricated corner pieces, if available from sheet manufacturer. Provide manufacturer's edge and top sealant or mastic, and primers.
- E. Water Resistive Barrier: vapor-permeable, air- and moisture-barrier, building wrap, Section 2510.5.2.2. Furnish with seam tape, fasteners, and washers as recommended by manufacturer for proper installation.
 - 1. ASTM E84 Surface Burning Characteristics: Class A
 - 2. ASTM E96, Permeance: 23 perms, minimum, when tested using Method A
 - 3. ASTM E1677, Air Penetration Resistance: Type 1
 - 4. AATCC 127, Water Penetration Resistance: 210 cm, minimum
 - 5. Acceptable Products: DuPont, Tyvek CommercialWrap D, or equal, approved in accordance with Division 01, General Requirements, for substitutions.
- F. Pre-Formed Penetration Flashings: Products of Quickflash Weatherproofing Products, Inc., Las Vegas, NV, or approved equal.
- G. At soffits and horizontal surfaces; Diamond lath, 3.4 pounds per square yard expanded metal, cut from hot-dipped galvanized for 16" on center framing. For framing over than 16" on center use 3/8" rib expanded metal lath.
- H. Corner Mesh, inside corner: Expanded steel mesh, shaped to permit complete embedding in plaster, minimum 3-inches wide, galvanized finish, 7/8" ground depth.
- I. Corner Bead: Formed steel, minimum 26-gage thick, beaded edge, expanded steel mesh flanges, of longest possible length, sized and profiled to suit application, galvanized finish.
- J. Strip Lath: Expanded steel mesh, 4-inches wide, galvanized finish.
- K. Corner Expansion Joint: 26-gage galvanized, double V expansion joint formed to 90 degree for inside corners, 7/8" ground depth.
- L. Foundation Weep Screed: Formed steel, minimum 26-gage thick, galvanized finish, holes to relieve trapped moisture. 4-inches flange height. Install minimum 4-inches above earth or 2-inches above paved areas.
- M. Parting Screed: 26-gage galvanized steel, separation type, single point screed. Between floor levels and as indicated.

- N. Casing Bead: Formed steel; minimum 26-gage thick, thickness governed by plaster thickness, maximum possible lengths, expanded or short flange with square edges to suit plaster applications, galvanized finish.
- O. Expansion Joint: Formed steel, minimum 26-gage thick, Adjustable Expansion Joint ClarkWestern, Riverside, CA, #40 or equal, 2-inch metal flanges each side, galvanized finish, 1/4 to 5/8-inch adjustment, thickness of cement plaster.
- P. Stress Relief Control Joint: Formed steel, minimum 26-gage thick, galvanized, with clean-up tape, ClarkDietrich Building Systems, Riverside, CA, XJ15-3, 7/8" ground depth, or equal.
- Q. Anchorages:
 - 1. Approved self-tapping, self-drilling 7/16 inch wafer head or pan-washer head galvanized metal screws, ASTM C1063, to rigidly secure lath and associated metal accessories in place, minimum penetration into steel framing supports 3/8"-inch. Lath shall be held back from vertical supports a minimum of 1/4-inch, per reference standard listed in Table 2507.2, CBC. For horizontal application fit screws with 1inch OD by 1/4 inch ID by 16 gage cut washers.
 - 2. Tie Wire: 18-gage annealed, galvanized.
- R. Reveals: Extruded aluminum reveal moldings as detailed and as manufactured by Fry Reglet Company, Alhambra, CA or equal as approved in accordance with Division 01, General Requirements for substitutions. All intersections shall be factory fabricated with joints heliarc welded and backs sealed with permanent waterproof tape. Furnish with 6-inch legs to join with straight sections. Provide connector clips and sealant at butt joints of straight sections and end caps at terminations.
 - 1. Sizes: refer to drawings.
 - 2. Finish: Clear anodized, Class II, Architectural 204R1 medium etch, .40 mils (AA-M12C22A31).
 - 3. Finish: Color anodized. two-step impregnated color Class II Architectural 0.40-0.70 mils (AA-M12C22A33).
 - 4. Finish: Polyester Power paint: 1.2mils exceed AAMA 2605.
 - 5. Finish: Kynar 500 Premium Finish: 70% PVDF resin, 0.30 mil for primer and 1.0 mil for finish coat, per AAMA 2605.
 - 6. Finish: Primed for field paint: Chemical conversion coat finish: Treatment of aluminum moldings shall conform with ASTM ND1730, Type B.
 - 7. Finish: Primed for field paint: Factory spray and bake-on primer to serve as base for field painting.
 - 8. Custom Colors: Selected by Architect.
- S. Soffit Vents: Galvanized steel material, 4-inch soffit vent unless otherwise noted on drawings. By Belmont, CA, Flannery, Inc., San Fernando, CA, Fry Reglet Company, Alhambra, CA, or equal.
- T. Drip Screed: At soffits, preformed 24 gauge galvanized, 4" flange, ½" holes to key plaster to molding.
- U. Door and window drips at heads of doors and windows in exterior walls where no roof or overhead protection occurs :

- 1. At non-recessed or flush conditions: Provide drips of anodized aluminum, 6063 alloy T5, extend drip edge minimum 1-1/2". Product: Flannery Inc., Door Drip for 7/8" thick plaster, Minimum 2" attachment flange, or equal.
- At recessed or soffit conditions: Provide drips of anodized aluminum, 6063 alloy T5. Product: Fry Reglet Drip Screed, non-vented, No. DS-875-875 or equal.
- V. Plaster Ceilings and Soffit Suspended Support System: Conform to reference standard listed in Table 2507.2 and 2507.3, California Building Code for sizes, types and spacing of ceiling support components. Steel: 33k psi, minimum yield strength, 0.0538" (16 gauge) minimum thickness, galvanized ASTM A653 G-60,
 - 1. Main Runners: 1-1/2", 0.414 lbs/ft cold-rolled channel, spaced at 3'-0" on center.
 - 2. Cross-runners: 3/4", 0.277 lbs/ft cold-rolled channels, spaced at 16" on center.
 - 3. Vertical hanger wires are #8-gage and galvanized, hanger wires shall be spaced at 4'-0" maximum.
 - 4. Compression Strut: 1-1/2-inch x 16 GA CRC (cold-rolled channel) compression strut at 16 sq. ft.

2.04 CEMENT PLASTER MIXES

- A. Mix and proportion Portland cement plaster in accordance with California Building Code Section 2512.1 Table 2507.2 and ASTM C926.
- B. Acrylic Finish Coat: Pre-mixed to manufacturer's recommendations.
- C. Mix materials dry to uniform color and consistency before adding water.
- D. Protect mixtures from frost, contamination and evaporation.
- E. Do not re-temper mixes after initial set has occurred.

PART 3 - EXECUTION

- 3.01 INSPECTION
 - A. Verify that surfaces and site conditions are ready to receive Work.
 - B. Grounds and Blocking: Verify items within walls for other Sections of Work have been installed.
 - C. Mechanical and Electrical: Verify services within walls have been tested and approved, otherwise uncover at no extra cost to Owner.
 - D. Beginning installation means acceptance of existing conditions.
- 3.02 PREPARATION
 - A. Protect floors, walls, trim and other surfaces near Work of this Section from damage or disfiguration.
 - B. Scaffolding: Construct and maintain in conformance with applicable laws and ordinances.

- C. Water Resistive Barrier. Cover surface scheduled for plaster with water resistive barrier sheet. Secure with mechanical fasteners, using suitable washers. Tape seams and laps as recommended by sheeting manufacturer. Coordinate with installation of flashing at openings and penetrations.
- D. Install window/door self-adhered flexible flashings after installation of the water resistive barrier. Install water resistive barrier as follows:
 - 1. Make a modified "I-cut" in the water resistive barrier.
 - 2. Cut a flap above the rough opening to allow head flashing installation.
 - 3. Fold side and bottom flaps into rough opening and secure. Flip head flap up and temporarily secure.
 - 4. Apply flexible flashing at sill; width of flashing shall be full depth of rough opening plus 4-inches minimum and length shall be at least 12-inches longer than width of opening. "Fan" flexible flashing at bottom corners and adhere onto face of walls. Make sure inside corners are tight without gaps.
 - a. Sill flashing not required for doors at first floor slab-on-grade construction.
 - 5. Install pre-formed sheet metal sill pan in full bed of mastic.
 - a. For doors at first floor slab-on-grade construction, pre-formed sheet metal corner pans may be installed at both sides in lieu of full sill pan.
 - 6. For face-flange type window/door assemblies, install with full bed of mastic prior to remaining flashings.
 - 7. Install flexible flashing at sides of opening; extend 6-inches minimum above top of rough opening to below bottom of sill flashings and pans.
 - a. For face-flange type assemblies, install 4-inch wide flashing covering flanges.
 - b. For other openings, width of flashing shall be full depth of rough opening plus 4-inches minimum.
 - 8. Install flexible flashing at top of opening; extend beyond outside edges of both jamb flashings.
 - a. For face-flange type assemblies, install 4-inch wide flashing covering flanges.
 - b. For other openings, width of flashing shall be full depth of rough opening plus 4-inches minimum.
 - c. Flip head flap down over the head flashing and secure with sealing tape.
 - 9. Metal Door/Window Head Drip: required at all openings not protected by overhangs and other openings as indicated in the Drawings.
 - a. For face-flange type assemblies, install metal drip after installation of jamb flashings and before head flashing, over the flange.
 - b. For other openings, install drip after installation of the head flashing and before turning down flap of water resistive barrier (water resistive barrier laps over metal drip.
- E. Install pre-formed penetration flashings.
- 3.03 INSTALLATION OF SUSPENDED PLASTER CEILING AND SOFFITS
 - A. Install Plaster Ceiling Suspended Support System in accordance with reference standard listed in Table 2511.1.1, California Building Code; sizes, types and spacing of ceiling support components and methods.

- B. Hanger wires shall be saddle-tied around main runners to develop full strength of the hangers.
- C. Attach cross runners to main runners by saddle tying with one 16 GA or two strands of 18 GA. Wires per Sections 2507.2 and 2511.1.1.
- D. Apply diamond metal lath with long dimension perpendicular to supports. Lap not less than 1/2 inch at sides and 1 inch at ends. Where laps do not occur over supports, secure tied with minimum 18 gage wires.
- E. Attach horizontal lath to metal supports with minimum 18 GA tie wires spaced not more than 6-inches on center, per Sections 2507.2 and 2511.1.1 or an agency-approved equivalent attachment. Apply with long dimension of sheets perpendicular to supports.
- 3.04 INSTALLATION LATHING MATERIALS
 - A. Diamond Lath at horizontal Surfaces Furred Ceilings and soffits: secure diamond metal lath to each support with minimum 18 gage tie wires spaced not more than 6 inches on center, per Sections 2507.2 and 2511.1.1 or an agency-approved equivalent attachment. Apply with long dimension of sheets perpendicular to supports lapped not less than 1/2 inch at sides and 1inch at ends.
 - B. Welded wire lath at vertical supports, apply self-furring paper-backed lath shingle style with self-furring rib perpendicular to supports. Attach lath to supports using approved screws at 6-inch centers, stagger vertical laps, lapped not less than one mesh at sides and ends but not less than 1 inch. Install screws at lath wire "high" location away from the designated fastener location. At rigid backing, secure lath with specified screws to maintain 1/4-inches from sheathing for proper keying of plaster.
 - C. Expanded metal lath at vertical supports, apply self-furring "grooved" metal lath with self-furring rib perpendicular to supports. Attach metal lath to supports using approved screws at 6-inch center. Stagger vertical laps. Lap not less than 1/2" at sides and 1 inch at ends. At rigid backing, secure lath with specified screws to maintain 1/4-inches from sheathing for proper keying of plaster.
 - D. Hold lath 1/4-inch away from vertical supports majority of the wall area in accordance with DSA Circular 25-1.
 - E. Continuously reinforce internal angles with corner mesh, except where metal lath returns 3-inches from corner to form angle reinforcement. Fasten at perimeter edges only.
 - F. Place beaded external angle with mesh at corners. Fasten at outer edges only.
 - G. Place strip lath diagonally at corners of lathed openings. Secure rigidly in place.
 - H. Place strip lath centered over junctions of dissimilar backing materials on same plane. Secure rigidly in place.

- I. Place casing beads at terminations of plaster finish. Butt and align ends, cope or miter at corners. Secure rigidly in place, maximum 12 inches on center.
- J. Install accessories to lines and levels.
- 3.05 CRACK CONTROL AND EXPANSION JOINTS
 - A. Control Joints: Install control joints at locations indicated on Drawings, and as follows:
 - 1. As required to delineate plasterwork into areas (panels) of the following maximum sizes
 - a. Vertical Surfaces: 144 sq. ft.
 - b. Horizontal and other Non-vertical Surfaces: 100 sq. ft.
 - 2. At distances between control joints of not greater than 18 feet o.c.
 - 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
 - 4. Where control joints occur in surface of construction directly behind plaster.
 - 5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.
 - B. Locate Expansion Joints at building expansion joints and as indicated on Drawings. At Expansion Joints, provide independent (double-stud) framing behind each side of joint. Apply 2 layers of Self-Adhesive Flashing centered behind joint; first layer 18-inches wide and second layer 12-inches wide, entire length of joint. Install expansion joint over flashing. Cut (discontinue) lath and install over joint flanges on each side of joint; do not span expansion joint with lath.
 - C. Make control- and expansion-joints with specified joint devices.
 - D. Obtain Architect's approval of joint placement before plastering.
 - E. Apply one-component polyurethane sealant at splices, intersections and terminations in accordance with Section 07 92 00.
 - F. Install reveal moldings according to manufacturer's instructions.
 - G. Paint per Section 09 90 00, Painting. Colors as selected by Architect.
- 3.06 PLASTERING
 - A. Two-Coat Plaster system (base and finish) not permitted.
 - B. Apply plaster in accordance with Section 2512 Exterior Plaster California Building Code.
 - 1. Measuring Ingredients: Proportion and measure ingredients by means of calibrated boxes or containers of such nature that quantities measured can be readily and accurately checked at any time. Proportioning by shovel measure is not acceptable.

- 2. Mixing Plaster: Mix plaster by machine for minimum of 2 minutes. Mix no more plaster than can be properly placed within 1/2 hour after mixing. Allow no material to remain overnight in mixers or mixing boxes. Thoroughly clean tools and implements used in mixing and transporting plaster.
- C. Apply scratch coat to nominal thickness of 3/8-inch, brown coat to nominal thickness of 3/8-inch, and a finish coat to nominal thickness of 1/8-inch over metal lathed surfaces.
- D. Moist cure scratch and brown coat minimum 48 hours each coat. Refer to Section 2512.6 California Building Code for alternate methods of application.
- E. After curing, dampen base coat prior to applying finish coat.
- F. Smooth Trowel Finish: Apply finish coat and steel trowel to a smooth and consistent finish as defined in "Plaster Textures" publication of WWCCA / Technical Services & Information Bureau, Fullerton, CA. Apply after brown coat has cured minimum 7 days.
- G. Avoid excessive working of surface. Delay trowelling as long as possible to avoid drawing excess fines to surface.
- H. Paint Portland cement finish under Section 09 90 00, Painting. Colors specified in Section 09 06 00.
- 3.07 TOLERANCES
 - A. Maximum Variation from True Flatness (discounting texture): 1/8-inch in 10 feet, non-accumulating.
 - B. Finished work shall be uniform in color and texture. Any areas of integrally colored plaster finish considered unacceptable to the Architect for reasons of color shade variations shall be fog coated at no expense to the Owner.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Gypsum Board Panels.
- B. Vertical wall gypsum board application.
- C. Taped and sanded joint treatment.
- D. Repair of Gypsum Board surfaces.
- E. Related Sections
 - 1. Section 05 40 00, Cold-Formed Metal Framing.
 - 2. Section 09 90 00, Painting

1.02 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM C475 Joint Compound and Joint Tape for Finishing Gypsum Board.
 - 2. ASTM C645 Specification for Nonstructural Steel Framing Members.
 - 3. ASTM C754 Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - 4. ASTM C840 Application and Finishing of Gypsum Board.
 - 5. ASTM C954 Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. to 0.112 in. in thickness.
 - 6. ASTM C1002 Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases.
 - 7. ASTM C1177 Glass Mat Gypsum Substrate for Use as Sheathing.
 - 8. ASTM C1178 Glass Mat Water-Resistant Gypsum Backing Panel.
 - 9. ASTM C1396 Specification for Gypsum Board.
- C. Underwriters Laboratories, Inc. (UL)
 - 1. UL Directory Fire Resistance Directory, Volume 1, Latest Edition.
- D. Gypsum Association (GA)
 - 1. GA-201 Gypsum Board for Walls and Ceilings
 - 2. GA-214 Levels of Gypsum Board Finish
 - 3. GA-216 Application and Finishing of Gypsum Board
 - 4. GA-600 Fire Resistance Design Manual
 - 5. GA-226 Gypsum Board installation on Curved Walls.
- E. 2016 California Building Code (CBC)
 - 1. CBC-7 Chapter 7, Fire Resistant Materials and Construction
 - 2. CBC-19A Chapter 19A, Concrete (for DSA)
 - 3. CBC-25 Chapter 25, Gypsum Board and Plaster.
- F. Division of the State Architect, Interpretation of Regulations (DSA-IR)
 - 1. DSA-IR 25-3.13, Drywall Ceiling Suspension Conventional Construction-One Layer.
 - 2. DSA-IR 25-2.13, Metal Suspension Systems for Lay in Panel Ceilings.
- 1.03 SUBMITTALS
 - A. Product Data: For each type of product indicated.
 - B. Shop Drawings: Show locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.
 - C. Samples: For following products:
 - 1. Trim Accessories: Full-size sample in 12-inch-long length for each trim accessory indicated.
- 1.04 QUALITY ASSURANCE
 - A. Applicator: Company specializing in gypsum board systems work with three years' experience.
- 1.05 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
 - B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.
 - C. Steel Framing and related accessories shall be stored and handled in accordance with AISI Code of Standard Practice.
- 1.06 WARRANTY
 - A. Provide manufacturer's warranty, 3 years against manufacturing defects.
- 1.07 PROJECT CONDITIONS
 - A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products of following manufacturer form basis for design and quality intended:
 1. United States Gypsum Corporation (USG), Chicago, IL.
- B. Subject to compliance with requirements, other acceptable manufacturers include the following:
 - 1. Georgia-Pacific, Atlanta, GA.
 - 2. National Gypsum Co./Gold Bond Building Products, Charlotte, NC.
 - 3. CertainTeed Corporation, Valley Forge, PA.
 - 4. Temple-Inland Forest Products, Diboll, TX.
- C. Or equal as approved in accordance with Division 01, General Requirements for Substitutions.
- 2.02 BOARD MATERIALS
 - A. Regular Gypsum Board: ASTM C1396; 5/8 inch thick, maximum permissible length; ends square cut, tapered round edges, USG SHEETROCK BRAND TAPERED GYPSUM PANELS SW.
 - B. Fire-rated Gypsum Board, 1HR: ASTM C1396; Type X, fire resistive type, 5/8 inch thick, maximum permissible length; ends square cut, tapered round edges, USG SHEETROCK BRAND FIRECODE, or equal.

2.03 MATERIALS

- A. Furring Channels: 25 gauge galvanized steel, 7/8 inch deep by 2-9/16 inch wide hat channels, 275 pounds per 1,000 feet weight, FHC-25 and CEMCO METAL FURRING CHANNEL CLIPS. Z Type, where required: CEMCO Z-FURRING CHANNEL, 1", 1-1/2", 2" and 3" depths.
 - 1. Dietrich UltraSteel Framing, 25 gauge or equal.
- B. Angles: 1-3/8 inch by 7/8 inch, 24 gauge, Dietrich Metal Framing, CEMCO GALVANIZED METAL ANGLES or equal.
- C. Tie Wire: 18 gauge galvanized annealed.
- D. Taping, Bedding and Finishing Compound: ASTM C475; compatible with tape and substrate.
 - 1. USG SHEETROCK Brand Taping Joint Compound Ready-Mixed, drying-type, non-asbestos, vinyl base.
 - 2. USG SHEETROCK Brand Topping Joint Compound Ready-Mixed, drying-type non-asbestos, vinyl base.
 - 3. USG SHEETROCK Powder Joint Compound, drying-type, non-asbestos vinyl base, conventionally drying. For Taping and Topping.
 - 4. USG SHEETROCK Powder Setting-type Joint Compound, chemical hardening.

- 5. Contractor's Option: USG SHEETROCK Lightweight All Purpose Joint Compound (Plus 3) with Dust Control.
- 6. USG SHEETROCK Brand All Purpose Joint Compound Ready-Mixed for laminating gypsum panels in multilayer partitions.
- 7. USG SHEETROCK Brand Joint Tape-Heavy, ASTM C475, high strength cross-fibered paper tape.
- 8. Drywall Primers: USG First Coat.
- 9. Or equal as approved in accordance with Division 01, General Requirements for substitutions.
- E. Accessories: Corrosive Protective-Coated steel.
 - 1. U-Trims: USG, Dietrich No. 200-A for joint compound or equal. [USG, Dietrich No. 801A for one-coat plaster system and No. 701A for two-coat plaster].
 - 2. J-Trim Casings, reveal type: USG, Dietrich No. 401 for 1/2" panels, 402 for 5/8" panels, no finishing compound.
 - 3. Control Joint: Dietrich 093, USG Control Joint No. 093, Zinc metal.
 - 4. Corner Bead: USG, Dietrich No. 103 for joint compounds or equal.
- F. Fasteners: Self-drilling tapping screws shall comply ASTM C 954; Self piercing screws shall comply ASTM C 1002;
 - 1. ASTM C1002, No. 2 Phillips recessed, bugle head, power-driven. Nails not permitted.
 - 2. Type S-12, ASTM C954, 16 gage steel studs, minimum penetration 3/8 inch.
 - 3. Type S, ASTM C 1002, 20 gage steel studs, minimum penetration 3/8 inch.
 - 4. Type G, gypsum board to gypsum board, minimum penetration 1/2 inch.
 - 5. Type W, wood construction, minimum penetration 5/8 inch.
- G. Reveal Moldings: Extruded aluminum moldings as detailed and as manufactured by Fry Reglet Co., Alhambra, CA, or equal as approved in accordance with Division 01, General Requirements for substitutions. All intersections shall be factory fabricated with joints heliarc welded and backs sealed with permanent waterproof tape. Furnish with 6 inch legs to join with straight sections. Provide connector clips at butt joints of straight sections and end caps at terminations. Color as selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Fry Reglet Corp.
 - b. Gordon, Inc.
 - c. MM Systems Corporation.
 - d. Pittcon Industries.
 - 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, alloy 6063-T5.

PART 3 - EXECUTION

- 3.01 INSPECTION
 - A. Verify that site conditions are ready to receive Work.
 - B. Beginning installation means acceptance of substrate.

3.02 PREPARATION

- A. Delivery and Storage: Arrange for an adequate supply of materials on the jobsite so that progress of Work will be uninterrupted. Materials and accessories shall be delivered in original containers and bundles, and identified with the manufacturer's name and brand. Store gypsum board on flat, solid supports in dry areas, well protected from the elements.
- B. Provide fixtures, anchors, sleeves, inserts and miscellaneous items, and provide openings and chases as necessary. Prior to closing in and finishing of dry wall Work, ascertain that piping, conduit, ductwork and fixtures which are to be concealed and which penetrate gypsum boards are in place, tested and approved.
- C. Scaffolding: Construct, erect and maintain in conformance with applicable laws and ordinances.
- D. Protection, Patching and Cleaning: Adjacent surfaces of other materials shall be protected from damage. Dry wall surfaces that have been cut out shall be neatly patched. Damaged or defective gypsum board finish shall be replaced. During progress of Work, rubbish droppings and water materials shall be removed.
- E. Fire Protection: Where required, the Work shall comply with the requirements for the protection rating indicated in the governing building code.
- F. Fire Sprinkler System: In areas where sprinkler heads occur, exercise care when installing drywall work. Do not damage or obstruct the heads in any way.
- 3.03 GYPSUM BOARD INSTALLATION
 - A. Install gypsum board in accordance with ASTM C840, GA 201, GA 216 and Section 2508 California Building Code. Conform to DSA, IR 25-3.13. Use board types as indicated; if not indicated use board types as follows.
 - 1. Use Type X (fire-rated core) drywall unless indicated otherwise.
 - 2. Where gypsum wallboard is indicated as base for ceramic [and stone] tile [and FRP wall panels] use board types as follows
 - a. Use Type (moisture resistant) board, except as follows
 - b. At walls to which plumbing fixtures are mounted and portions of adjoining walls within 2'-0" of a plumbing fixture, install fiberglass-mat faced tile backer board to 4'-0" above the finished floor with Type WR, above, moisture and mold resistant gypsum board.
 - B. Non-rated: Erect single layer gypsum board parallel or perpendicular on vertical framing, attached to studs and framing members with the specified fasteners spaced at 16" on center with screws and at top and bottom, 12" on center with screws at ceilings. Solid backing not required at joints running perpendicular to studs and framing members for walls.
 - 1. For walls requiring STC 50 or higher, install extra layer of 1/2" gypsum board on one side, unless noted otherwise on wall schedule.

- C. Rated: Erect single fire-rated gypsum board panels in accordance with Table 705.4, Note a, and Section 708 California Building Code, and GA-600, for one-hour or two hour, fire-rated, non-bearing Fire Walls or Fire Partitions, steel or wood stud construction.
 - 1. Gypsum board panels installed parallel to vertical studs or framing shall be spaced at 8" on center with screws at vertical edges, and 12" on center with screws in field and at top and bottom, and 12" on center with screws at ceilings. Solid backing not required at joints running perpendicular to studs and framing members for walls. Stagger vertical joints 24 inches on centers each side and opposite sides. Where joints are not staggered required minimum 24 inches, solid backing shall be provided. All joints shall be treated except as provided herein.
 - 2. For walls requiring STC 50 or higher, install extra layer of 1/2" gypsum board on one side, unless noted otherwise on wall schedule.
- D. Treat cut edges and holes in moisture-resistant gypsum board with sealant.
- E. Place control joints consistent with lines of building spaces as indicated or at maximum of 30 ft on centers. At rated walls, provide with fire rated panels same as wall construction.
- F. Place corner beads at external corners. Use longest practical length. Place edge trim where gypsum board abuts dissimilar materials.
- G. Seal all cutout and penetrations: For electrical, mechanical, plumbing and structural framing cutouts and penetration at interior surfaces. Per Section 07 92 00 for non-rated wall, and fire-rated sealant for rated walls per section 07 84 00.
- H. Foil-backed gypsum board shall be applied on the inside of exterior walls.
- I. Install reveal moldings according to manufacturer's recommendations.

3.04 JOINT TREATMENT

- A. Exposed gypsum board in wall areas and ceiling areas shall have joint compound and be taped and sanded per requirements of GA-114 for levels specified and ready for paint.
- B. On installations where two layers of gypsum board are required, only the face layer will require finishing of joints and screwheads.
- C. Gypsum wallboard joints in walls may either be exposed or covered with joint tape and joint compound for the portion of the wall above a suspended ceiling, which is part of a fire resistive floor-ceiling or roof-ceiling assembly, as listed in U.L. Fire Resistive Ratings (BXUV), when the following conditions are met:
 - 1. Vertical joints occur over framing members.
 - 2. Horizontal joints are staggered 24 inches on opposite sides or covered with 6 inch wide strips of gypsum board attached with 1-1/2 inch laminating screws at 8 inches on centers.
 - 3. Partition is two-ply system with joints staggered 16 inches or 24 inches.

- 4. Partition is not part of a smoke or sound control system.
- D. Fire-Rated Partitions: Perimeters of fire-rated partitions shall be caulked with fire-rated sealant as specified in Section 07 84 00, both sides of partition.
- E. Sound-Rated Partitions: Perimeters and penetrations of sound-rated partitions shall be caulked with acoustical sealant as specified in Section 07 92 00, both sides of partition.
- F. Joints, except where excluded above including internal corners, shall be filled and taped. Thin uniform layer of joint compound, approximately 3 inches wide, shall be applied over joint. Tape shall be set in joint compound and finish levels required below. Internal angles, both horizontal and vertical, shall be reinforced and with tape folded to form straight and true angle. Metal external corners shall be set in place. Joints shall be allowed to dry at least 24 hours between each application of cement.
- G. Gypsum board finish shall be to the following levels as defined by GA-214:
 - 1. Plenum areas above ceilings Level 1.
 - 2. Substrate for tile, tackable wall panels, tackboards and markerboards Level 2.
 - 3. Areas receiving heavy textured paint Level 3.
 - 4. Level 4: not used.
 - 5. All Areas (shall be Level 5) receiving non-textured, flat, egg-shell, gloss or semi-gloss paint Level 5. Backroll application of sealer. Level 5 requires one of the following.
 - a. Skim coat: A thin skim coat of joint compound, or a material manufactured especially for this purpose, shall be applied to entire surfaces. Surfaces shall be smooth and free of tool marks and ridges.
 - b. Acrylic latex-based coating, spray apply: USG SHEETROCK Brand Primer-Surfacer Tuf-Hide or ProForm Surfacer/Primer by National Gypsum or equal. Apply to 15-20 mils wet film thickness to entire surface.
 - c. "Smooth Coat" level 5 by Westpac Materials, Orange, CA.
 - d. Additionally apply primer coat per Section 09 90 00 Painting.

3.05 REPAIR OF GYPSUM BOARD SURFACES

- A. Before any work is started, cover all floors completely with canvas and protect all surfaces.
- B. Ceilings: Air blow, broom, rag and dust all surfaces to remove as much dust and dirt as possible. Hand scrape and machine wire tool to remove all loose and peeling paint to a tight edge.
- C. Interior Walls: Repair all walls after ceilings are completed.
- D. Remove contamination from surfaces. Repair and match new panels to align and to match adjacent surfaces. Feather edges into the existing adjacent surface. Repair cracks, holes, gouges and damaged spots larger than 1/2", tape joints and finish per this section. Paint per Section 09 90 00.
- E. Plaster Surfaces: Fill hairline cracks, small holes and imperfections with patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces

3.06 TOLERANCES

- A. Maximum Variation from True Flatness: 1/8 inch in 10 feet in any direction.
- B. Must provide flat finished surface prior to installation of Acoustical Suspension System wall angles and accessories. Coordinate with Section 09 53 23.

END OF SECTION

SECTION 09 51 00

ACOUSTICAL CEILINGS - LAY-IN

PART 1 - GENERAL

- 1.01 WORK INCLUDES
 - A. Acoustical panels, lay-in.
 - B. Related Sections:1. Refer to drawings for Finish Schedule.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. CBC California Building Code, 2016
 - C. ASTM E84 Surface Burning Characteristics of Building Materials.
 - D. ASTM E1264 Acoustic Ceiling Products.

1.03 SUBMITTALS

- A. Product data for acoustical panels.
- B. Three samples illustrating material and finish of acoustic units.
- C. Manufacturer's installation instructions.
- 1.04 QUALITY ASSURANCE
 - A. Qualifications
 - 1. Manufacturer: Company specializing in manufacture of ceiling panels with five years minimum experience.
 - 2. Installer: Company with three years minimum experience.
 - B. Fire Classification Requirements: ASTM E84, flame spread of less than 25 and smoke density rating of less than 450, Class I, California Building Code Table 803.5, 2016 CBC, Tables 8A and 8B.
- 1.05 ENVIRONMENTAL REQUIREMENTS
 - A. Interior wet work shall be completed prior to installation of panels. Windows and doors shall be in place. HVAC systems shall be installed and operable where necessary to maintain a temperature range of 60 to 85 degrees F and maximum 70 percent relative humidity.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products of the following manufacturers form the basis for design and quality intended.
 - 1. Armstrong World Industries, Lancaster, PA.
 - 2. USG Corporation, Chicago, IL.
 - 3. CertainTeed Corporation, Malvern, PA.
- B. Or equal as approved in accordance with Division 01, General Requirements for substitutions.

2.02 MATERIALS

- A. AC1: Armstrong Clean Room VL Non-Perforated No. 870, ASTM E1264.
 - 1. Size: 24 by 48 inches
 - 2. Thickness: 5/8 inch.
 - 3. Edge: Square.
 - 4. Surface Color: Factory White.
- B. AC2: Armstrong Cortega No. 769A, ASTM E1264.
 - 1. Size: 24 by 48 inches
 - 2. Thickness: 5/8 inch.
 - 3. Edge: Beveled Tegular 15/16"
 - 4. Surface Color: Factory White.
 - 5. Match existing ACT Tile.
- C. Retention Clips: Armstrong #414 Retention Clip or equal. Refer to INSTALLATION Part 3 for conditions requiring clips.
- D. Refer to drawings for finish schedule.
- PART 3 EXECUTION
- 3.01 INSPECTION
 - A. Verify that existing conditions are ready to receive work.
 - B. Verify that layout of hangers will not interfere with installation of acoustic units.
 - C. Beginning of installation means acceptance of existing conditions.
- 3.02 INSTALLATION
 - A. Conform to Interpretation of Regulations DSA IR 25-2.13.
 - B. Fit acoustic units in place, free from damaged edges or other defects detrimental to appearance and function.

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- C. Where square units are indicated, lay directional patterned units in basket weave pattern. Fit border neatly against abutting surfaces.
- D. Install acoustic units level, in uniform plane, and free from twist, warp and dents. Replace damaged or soiled units.
- E. Provide for complete accessibility for all units.

END OF SECTION

SECTION 09 53 23

ACOUSTICAL SUSPENSION SYSTEMS

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Suspended metal grid ceiling system.
 - B. Perimeter trim.
 - C. Related Sections:1. Section 09 51 00, Acoustical Ceilings.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ASTM C635 Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
 - C. ASTM C636 Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
 - D. ASTM E84 Surface Burning Characteristics of Building Materials.
 - E. ASTM E580 Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Seismic Restraint.
 - F. ASCE/SEI 7-10 American Society of Civil Engineers/Structural Engineering Institute, Standard 7-10.
 - G. CBC 2016 California Building Code.
 - H. Chapter 19A, 2016 California Building Code.
 - I. Chapter 23, 2016 California Building Code.
 - J. Metal Suspension Systems for Lay-in Panel Ceilings. Interpretation of Regulations DSA IR 25-2.13.
- 1.03 SUBMITTALS
 - A. Shop drawings indicating, grid layout and related dimensioning, junctions with other work or ceiling finishes and interrelation of mechanical and electrical items. Photographic reproductions of the contract drawings shall not be used.
 - B. Product data.
 - C. Three samples of each suspension system main runner, cross runner and edge trim.

- D. Manufacturer's installation instructions.
- E. Submit one copy of ICC-ES Reports Armstrong ICC-ES, ESR-1308
- 1.04 QUALITY ASSURANCE
 - A. Manufacturer: Company specializing in manufacture of ceiling suspension system with five years minimum experience.
 - B. Installer: Company with five years minimum experience.
 - C. Fire Classification Requirements: ASTM E84, all materials shall have Flame Spread Index rating of less than 25 and Smoke Developed Index rating of less than 450.
 - D. Products must comply with ICC-ES Reports.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products of following manufacturers form basis for design and quality intended.
 - 1. Armstrong World Industries. Lancaster, PA. Product: Prelude XL, 15/16 inch Exposed Tee.
 - 2. CertainTeed Corporation, Malvern, PA.
- B. Or equal as approved in accordance with Division 01, General Requirements for substitutions.
- 2.02 SUSPENSION SYSTEM MATERIALS
 - A. Grid: ASTM C635, Armstrong Prelude Heavy Duty XL 15/16" ceiling system, galvanized components die cut and interlocking.
 - 1. Main Runners:
 - a. Armstrong: Heavy Duty Prelude XL 7301, exposed T.
 - 2. Cross Tees "Stake-on end", Stepped End:
 - a. Armstrong: XL7328 (24 inch grid), XL7341 (48 inch grid).
 - 3. Edge Trim:
 - a. Armstrong Angle Molding: 7800, 7/8", Prelude with BERC2 Retention Clip .
 - B. Beam End Retention Clip: slide clip for free end of main-runners and cross-tees with 2-inch movement capability.
 - 1. Acceptable Product: Armstrong, BERC2, or equal,
 - C. Accessories: clips, adapters, splices, edge trim and all necessary components required for the specified suspended grid system.

- D. Grid Materials: main runners, cross runners, splices, expansion devices and intersection connectors, commercial quality cold rolled steel with galvanized coating. Designed to carry a mean ultimate test load on not less than 180 lbs. compression and tension per ASTM E580 Section 5.1.2. The ceiling grid system must be rated as Heavy Duty as defined by ASTM C635.
- E. Grid Finish: Factory applied standard white.
- F. Hanger Wire: No. 12 gauge wire shall be 0.106 inch in diameter conforming to ASTM A641. No. 12 gage wire shall be soft annealed, galvanized steel wire with a Class 1 zinc coating.
- G. Compression Struts, one of the following:
 - Stud Design: Install a 20-gauge 4-inch stud. Attach to main runner with 2 #12 self-drilling self-tapping screws within 2 inches of splay intersection and to structure, with 2 #12 x 2 inch long screws to wood structure or 3/16-inch diameter expansion anchor at concrete/steel deck or 2 #10 x 1/2" self-tapping sheet metal screws to metal deck without concrete. Compression strut shall not replace hanger wire, refer to drawings. [DSA IR 25-2.13 Sheet No. 2.35.]
 - 2. Pipe Design: Install a 12 GA. vertical hanger wire and tie to main runner no more than 2 inches from splay intersection. Run the hanger wire inside a sleeved 1/2-inch Electrical Rigid Steel Conduit or Steel Electrical Metallic Tubing (EMT) and 3/4 inch Electrical Rigid Steel Conduit (ERSC) or Steel Electrical Metallic Tubing (EMT) as indicated on drawings, extend tubes tight to structure above and ceiling grid below. To secure sleeved tubes drill a 5/32-inch hole and install through a 1/8-inch bolt with locking nut, tubes shall lap one another min. 4 inches in fully extended position. Cut a slot in the 3/4-inch conduit to straddle the main runner and secure with 2 #12 self-tapping sheet metal screws.
 - 3. Install a USG DONN Compression Strut Posts, Model VSA18/30 for up to 30 inches plenum depth, Model VSA30/48 for up to 48 inches and VSA 48/84 for up to 84 inches and VSA84/102 for up to 102 inches. Provide required accessories for seismic requirements and secure per manufacturer's specifications. Compression strut post shall not replace hanger wire.
 - 4. Truss Joists Design: Install web stiffeners at 24 inches long. Attach clip angle L 2-1/2 by 2-1/2 by 1/4 inches and secure to joist with 3/8 inch diameter bolts with washers, hang splay wire from angle with 3/8 inch eyebolt, secured with washers and nut. Attach 1/2 inch diameter galvanized pipe strut, maximum length 51 inches, to side of joist or web stiffener with1/4 inch diameter. Lag bolt and washer, provide spacer between pipe and joist/stiffener.

PART 3 - EXECUTION

- 3.01 INSPECTION
 - A. Verify that existing conditions are ready to receive work.
 - B. Verify that layout of hangers will not interfere with other work.
 - C. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

- A. Install system in accordance with ASTM C636 and Section 5.2 of ASTM E580, CBC Sections 1616A.1.21, and DSA IR 25-2.13, and as supplemented in this Section.
- B. Measure each ceiling area and establish layout to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width grid panel at borders and comply with layout shown on reflected ceiling plans.
- C. Exitways shall be installed in accordance with Section 13.5.6.2.2.(1) of ASCE 7-10 as amended by 2016 CBC Section 1616A.1.21. A main or cross runner shall be installed on all sides of each piece of tile, board or panel and each light fixture or grill. Splices and intersections of such runners shall be attached with through-connectors such as pop rivets screws, pins, plates with bent tabs or by other approved connectors.
- D. Ceilings shall not support material or building components other than grilles or light fixtures except as herein provided. Ductwork, plumbing and like work shall have its own support system and shall not utilize the ceiling system or suspension wires.
- E. No. 12 gage hanger wires may be used for up to and including 4 ft. by 4 ft. grid spacing and shall be attached to main runners.
- F. Provide No. 12 gauge hanger wires at the ends of all main and cross runners within eight (8) inches of the support or within one-fourth (1/4) of the length of the end tee, whichever is least, for the perimeter of the ceiling area. Perimeter wires are not required when the length of the end tee is eight (8) inches or less.
- G. Ceiling grid members shall be attached to two (2) adjacent walls per ASTM E580 Section 5.2.3 Ceiling grid members shall be at least 3/4 inch clear of other walls. If walls run diagonally to ceiling grid system runners, one end of main and cross runners should be free, and a minimum of 3/4 inch clear of wall.
- H. The width of the perimeter supporting closure angle shall be not less than 2 inches. Grid systems with specialty or proprietary angles and support clips may be acceptable in accordance with Acceptance of Evaluation Reports per DSA IR A-5 and meeting the requirements of CBC Section 1616A.1.21, ASTM C635, C636 and E580.
- I. At the perimeter of the ceiling area, where main or cross runners are not connected to the adjacent wall, provide interconnection between the runners at the free end to prevent lateral spreading. A metal spreader strut or a No. 16 gage wire with a positive mechanical connection to the runner may be used and placed within 8 inches of the wall. Where the perpendicular distance from the wall to the first parallel runner is 8 inches or less, this interlock is not required.
- J. Expansion Joints, Seismic Separation Joints, and Penetration:
 - 1. Expansion joints shall be provided in the ceiling at intersections of corridors and at junctions of corridors with lobbies or other similar areas.
 - 2. For ceiling areas exceeding 2500 square feet a seismic separation joint shall be provided to divide the ceiling into areas not exceeding 2500 square feet. Alternatively comply with ASTM E580, Section 5.2.9.

- 3. Penetrations through the ceiling for sprinkler heads and other similar devices that are not integrally tied to the ceiling system in the lateral direction shall have a two (2) inch oversized ring, sleeve or adapter through the ceiling tile to allow free movement of one (1) inch in all horizontal directions. Alternatively, per ASTM E580, Section 5.2.8.5, a flexible sprinkler hose fitting that can accommodate one (1) inch of ceiling movement shall be permitted to be used in lieu of the oversized ring, sleeve or adapter.
- K. Lateral Force Bracing:
 - 1. Lateral force bracing is required for all ceiling areas. The spacing of the bracing assemblies as indicated on drawings.
 - a. Exception: Lateral force bracing may be omitted for suspended acoustical ceiling systems with a ceiling area 144 sq. ft. or less, when perimeter support, in accordance with Paragraph H above or with ASTM E580 Sections 5.2.2 and 5.2.3, are provided and perimeter walls are designed to carry the ceiling lateral forces.
 - 2. Provide lateral-force bracing assemblies consisting of a compression strut and four (4) No. 12 gage splayed bracing wires oriented 90 degrees from each other.
 - 3. The spacing of the bracing assemblies must be shown on the construction documents.
 - 4. There shall be a brace assembly a distance not more than one half (1/2) the calculated spacing from the surrounding wall, expansion joint and at the edges of any ceiling vertical offset.
 - 5. Bracing assemblies spaced at a maximum of 12 feet by 12 feet on centers for school buildings and 8 feet by 12 feet on centers for essential services buildings, and
 - 6. The slope of bracing wires shall not exceed 45 degrees from the plane of the ceiling and wires shall be taut. Splices in wires are not permitted without special DSA approval.
 - 7. Compression struts shall be adequate to resist the vertical component induced by the bracing wires, and shall not be more than 1 (horizontal) in 6 (vertical) out of plumb.
 - 8. The maximum slenderness ratio (kL/R) of the compression strut is 200 or less.
- L. Attachment of Hanger and Bracing Wires:
 - 1. Fasten hanger wires with not less than three (3) tight turns in three inches. Hanger wire loops shall be tightly wrapped and sharply vent to prevent any vertical movement or rotation of the member within the loops.
 - 2. Fasten bracing wires with four (4) tight turns. Make all tight turns within a distance of 1-1/2 inches.
 - 3. Hanger or bracing wire anchors to the structure should be installed in such a manner that the direction of the anchor aligns as closely as possible with the direction of the wire.
 - 4. Separate all ceiling hanger and bracing wires at least six (6) inches from all un-braced ducts, pipes, conduits, etc.
 - 5. Hanger wires shall not attach to or bend around interfering materials or equipment. Provide trapeze or other supplementary support members at obstructions to typical hanger spacing. Provide additional hangers, struts or braces as required at all ceiling breaks, soffits, or discontinuous areas.

- 6. Hanger wires that are more than 1 (horizontal) in 6 (vertical) out of plumb shall have counter-sloping wires. Perimeter hanger wires at main runners that are positively attached to the perimeter closure angle, counter-sloping is optional.
- 7. When drilled-in concrete anchors or shot-in anchors are used in reinforced concrete for hanger wires, 1 of 10 wire/anchor assemblies must be field tested for 200 lbs. in tension. When drilled-in concrete anchors are used for bracing wires, 1 out of 2 wire/anchor assemblies must be field tested for 440 lbs. in tension in the direction of the wire. Power actuated fasteners in concrete are not permitted for bracing wires.
- M. Ceiling Fixtures, Terminals, and Devices:
 - 1. All fixture, terminals, and other devices shall be mounted in a manner that will not compromise ceiling performance in accordance with Section 13.5.6.2.2(5) of ASCE 7-10 as amended by 2016 CBC Section 1616A.1.21 (1616.10.16) and ASTM E580 Sections 5.3 and 5.4.
 - 2. Attach all light fixtures and ceiling mounted air terminals, to the ceiling grid runners to resist a horizontal force equal to the weight of the fixtures. Screws or approved fasteners are required.
 - 3. Ceiling panels shall not support any light fixtures, air terminals or devices.
 - 4. All light fixtures shall be positively attached to the ceiling suspended systems by mechanical means to resist a horizontal force equal to the weight of the fixture. Screws or approved fasteners are required. A minimum of two attachments are required at each light fixture, per ASTM E580, Section 5.3.1.
 - Light fixtures weighing less than or equal to 10 lb shall have a minimum of (1) #12 gauge slack safety wire connected from the fixture housing to the structure above.
 - 6. Light fixtures weighing greater than 10 lbs but less than 56 lbs may be supported directly on the ceiling runners, but they shall have a minimum of two (2) #12 gauge slack safety wires connected from the fixture housing at diagonal corners and anchored to the structure above.
 - 7. Light fixtures weighing greater than 56 lbs. shall be independently supported by not less than four (4) taut No. 12 gauge wires, each attached to the housing and to the structure above. The four (4) # 12 taut #12 wires, including their attachment to the structure above, must be capable of supporting four (4) times the weight of the unit.
 - 8. All 4ft. x 4 ft. light fixtures must have slack safety wires at each corner.
 - 9. Surface-mounted fixtures shall be attached to the main runner with at least two positive clamping devices made of material with a minimum #14 gauge. Rotational spring catches do not comply. A #12 gauge suspension wire shall be attached to each clamping device to the structure above. Provide additional supports when light fixtures are eight (8) feet or longer. Maximum spacing between supports shall not exceed eight (8) feet.
 - 10. Support pendant-mounted light fixtures directly from the structure above with hanger wires or cables passing through each pendant hanger and capable of supporting two (2) times the weight of the fixture. A bracing assembly is required where the pendant hanger penetrates the ceiling. If the pendant mounted light fixture is directly and independently braced below the ceiling, i.e. aircraft cables to walls, then brace assembly is not required above the ceiling.

- If the pendant mounted light fixture is not directly and independently braced 11. below the ceiling, than a bracing assembly is required where the pendant hanger penetrates the ceiling. Special details are required to attach the pendant hanger to the bracing assembly to transmit horizontal force. Exception: where the weight of the fixture is less than 20 pounds, the compression strut is not required.
- Rigid conduit shall not be used for attachment of the fixtures. 12.
- N. If non-bearing partitions that extend to and terminate at a suspended Partitions: ceiling are supported laterally by opposing bracing wires spaced a maximum of 8 ft oc along the top edge of the partition or by other equivalent means, they shall be considered as not adding to the lateral load required to be resisted by the ceiling system.
- Ο. Do not eccentrically load system or produce rotation of runners.
- Ρ. Install edge angle at intersection of ceiling and vertical surfaces using longest practical Miter corners. Provide edge angles at junctions with other interruptions. lenaths. Where curved obstructions occur, provide preformed closers to match edge molding.
- Q. Form expansion joints as indicated on drawings.
- R. Install Suspension Accent Trims per manufacturer's instructions including all related accessories.
- 3.03 TOLERANCES
 - Variation from Flat and Level Surface: 1/8 inch in 10 feet. Α.

END OF SECTION

SECTION 09 65 13

RESILIENT BASE

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Resilient base, rubber.
 - B. Accessories.
 - C. Related Sections1. Refer to drawings for Finish Schedule.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ASTM E648 and NFPA 253 Critical Radiant Flux of Floor Covering Systems.
 - C. ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
 - D. ASTM F1861 Resilient Wall Base
 - E. Local Local Air Quality Management District Regulations Adhesive and Sealant Applications
- 1.03 FIRE CLASSIFICATION REQUIREMENTS
 - A. ASTM E648, NFPA 253: Class 1, Critical Radiant Flux Flame Spread Value: minimum 0.45 watts per sq cm.
 - B. ASTM E662, smoke density less than 450.
- 1.04 SUBMITTALS
 - A. Product data on specified products and colors available.
 - B. Three 6 inch long samples of base material for each color selected.
 - C. Manufacturer's installation instructions.
 - D. Maintenance procedures and recommended maintenance materials.
- 1.05 ENVIRONMENTAL REQUIREMENTS
 - A. Store materials for three days prior to installation in area of installation to achieve temperature stability.

- B. Maintain minimum 70 degrees F temperature three days prior to, during and 24 hours after installation of materials.
- C. Provide adequate ventilation to carry off volatile fumes.
- 1.06 WARRANTY
 - A. Submit under provisions of Division 01, General Requirements.
 - B. Provide manufacturer's 1 year warranty against defects and wear-through.
- 1.07 REPLACEMENT MATERIALS
 - A. Provide minimum three percent of all materials furnished for each color and size of materials installed.

PART 2 - PRODUCTS

- 2.01 MANUFACTURERS, RUBBER
 - A. Johnsonite, Chagrin Falls, OH.
 - B. Burke Mercer Flooring Products, San Jose, CA.
 - C. Nora Flooring Systems, Lawrence, MA.
 - D. Endura Co., Waltham, MA.
 - E. Roppe Corp., Fostoria, OH.
 - F. Or equal as approved in accordance with Division 01, General Requirements for substitutions.
- 2.02 BASE MATERIALS
 - A. Base: Rubber, 1/8 inch gauge, standard toe unless noted otherwise .
 - B. Base material shall meet ASTM F1861 Type TS for rubber base, Group 1, Style A Straight (toeless) profile for carpet and Style B Coved profile for hard surface floors .
 - C. Base Accessories: size and color as base.
 - D. Adhesive: As recommended by the manufacturer and if full compliance with the California VOC regulations.
 - E. Non-aerosol adhesives applied on-site shall comply with VOC content limits defined by SCAQMD Rule 1168. Aerosol adhesives shall comply with VOC contents limits by Green Seal Standard GS-36.
 - F. Colors and Height: Refer to drawings for Finish Schedule. Match existing adjacent base.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are smooth and flat with maximum variation of 1/8 inch in 10 ft and are ready to receive Work.
- B. Verify that surfaces are finished, ready to receive base installation.
- C. Beginning of installation means acceptance of existing substrate and site conditions.
- 3.02 INSTALLATION BASE MATERIAL
 - A. Fit joints tight and vertical. Maintain minimum measurement of 18 inches between joints.
 - B. At 90 degree external corners: Cut from 120 foot rolls only, do not use 4 foot segments. At corners more or less than 90 degrees, shave a vertical strip down the back side of the material, 1/4 inch wide and not more than 1/2 the thickness at the point of bend. Bend coved toe to required angle. Bond material firmly to wall on both sides of joint to ensure a tight fit with no open void at top.
 - C. Inside Corners: Cut an inverted V-shaped notch in the toe of the wall base at the place where the corner is to be formed. Bend the base once or twice at a right angle to shape the corner. Form the corner and check the fit. Apply adhesive completely to the back of the base and to the wall area to be covered by the corner. Press firmly in position on and roll with a small hand roller.
 - D. Pre-molded units will not be accepted.
 - E. Install base on solid backing. Bond tight to wall and floor surfaces.
 - F. Scribe and fit to door frames and other interruptions.

3.03 CLEANING

- A. Remove excess adhesive from floor, base and wall surfaces without damage.
- B. Protection: Protect work until completion. Repair or make good any damage to this work and other materials damaged during installation of base material.
- 3.04 SCHEDULE
 - A. Install at all walls not specified to receive integral base and as scheduled in the finish schedule.
 - B. Do not apply base to toe kick at casework.

END OF SECTION

SECTION 09 65 19

RESILIENT TILE FLOORING

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Resilient tile flooring.
 - B. Accessories
 - C. Related Sections
 - 1. Section 09 05 61, Common Work Results for Flooring Preparation.
 - 2. Refer to drawings for Finish Schedule.

1.02 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. ASTM American Society for Testing and Materials
 - 1. ASTM E648 and NFPA 253 Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.
 - 2. ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
 - 3. ASTM F1066 Standard Specification for Vinyl Composition Floor Tile.
 - 4. ASTM F 1869 Test Method for Measuring Moisture Vapor Emission.
 - 5. ASTM F 2170 Determining Relative Humidity in Concrete Floor Slabs Using In-Situ Probes.
- C. ADA Americans with Disabilities Act of 1990
 - 1. ADA Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design.
- D. SCAQMD South Coast Air Quality Management District Regulations Rule 1168 Adhesive and Sealant Applications.
- 1.03 FIRE CLASSIFICATION REQUIREMENTS
 - A. ASTM E648, NFPA 253: Class I, Critical Radiant Flux: Minimum 0.45 watts per sq cm.
 - B. Smoke Density not greater than 450 when tested in accordance with ASTM E662.
- 1.04 SUBMITTALS
 - A. Product data on specified products, describing physical and performance characteristics, sizes, patterns and colors available.

- B. Three samples, 12 by 12 inches in size, illustrating color and pattern for each floor material specified.
- C. Manufacturer's installation instructions.
- D. Maintenance procedures and recommended maintenance materials, and suggested schedule for cleaning, stripping and re-waxing.
- E. Moisture and Alkalinity test results.
- 1.05 MOISTURE AND ALKALINITY TESTING
 - A. Contractor shall test all concrete floors to receive resilient flooring for moisture content as described in Division 01, General Requirements for Quality Requirements and this Section.
 - B. Notify Inspector 24 hours prior to installation of testing and at conclusion of tests.
 - C. Test concrete flooring in accordance with ASTM F1869 or ASTM F 2170.
 - D. Submit test results and data to Owner and Architect for approval prior to installation of flooring materials.
- 1.06 WARRANTY
 - A. Submit under provisions of Division 01, General Requirements.
 - B. Provide manufacturer's 5 year warranty against defects and wear-through.
- 1.07 ENVIRONMENTAL REQUIREMENTS
 - A. Store materials for three days prior to installation in area of installation to achieve temperature stability.
 - B. Maintain minimum 70 degrees F temperature three days prior to, during and 24 hours after installation of materials.
 - C. Provide adequate ventilation to carry off volatile fumes.
- 1.08 MAINTENANCE
 - A. Unless badly soiled or scratched, clean, seal and polish vinyl composition tile in accordance with this section.
 - B. Use only approved brushes to maintain polished finish.
 - C. Coordinate selection of floor polish with Owner's custodial maintenance representative.

PART 2 - PRODUCTS

- 2.01 REGULATORY REQUIREMENTS
 - A. Slip Resistant: Resilient Flooring shall be stable, firm, and slip resistant. CBC Section 11B-302.1.
- 2.02 MANUFACTURERS TILE FLOORING
 - A. Products of the following manufacturers form the basis for design and quality intended.
 - 1. Armstrong World Industries, Inc., Fullerton, CA.
 - 2. Azrock by Tarkett Commercial, Houston, TX.
 - 3. Mannington Commercial, Calhound, GA.
 - B. Or equal as approved in accordance with Division 01, General Requirements for Substitutions.
- 2.03 TILE FLOORING MATERIALS
 - A. ASTM F1066, Class 2/II, 1/8 (.125) inch thick, 12 by 12 inch size, homogeneous composition tile, pattern uniformly dispersed throughout thickness of material.
 1. Required Static Load Limit: 125 pounds per square inch.
 - B. Subfloor Leveler System: Johnsonite LS-40, pieces to fit transition condition. Install per manufacturer's specifications.
 - C. Product and manufacturer: Refer to drawings for Finish Schedule.
- 2.04 MANUFACTURERS REDUCER STRIPS AND ACCESSORIES
 - A. Products of the following manufacturers form the basis for design and quality intended.
 - 1. Johnsonite, Chagrin Falls, OH
 - 2. The Roppe Co., Fostoria, OH.
 - 3. Mercer Products Co., Inc., Orlando, FL.
 - 4. The Flexco Co., Tuscumbia, AL.
 - 5. AFCO Rubber Corp., North Canton, OH.
 - B. Or equal as approved in accordance with Division 01, General Requirements for Substitutions.
- 2.05 REDUCER STRIPS AND ACCESSORIES
 - A. Reducer Strip: JOHNSONITE, vinyl RRS-XX-C (1/8"), RRS-XX-B (.080") or RRS-XX-A (1/16") for thickness of flooring tile.
 - B. Edge Guards and Adapters: JOHNSONITE EG and CTA Series, thickness on each side of strip to accommodate type of flooring material to be jointed.

2.06 FILLERS AND ADHESIVES

- A. Subfloor Filler: Armstrong S-194 FLOOR PATCH [Mannington M-Guard V-11/Full Spread] or Ardex SD-F Feather Finish and Primer P-51 for concrete, P-82 for non-porous subfloors or wood and as recommended by the manufacturer of finish flooring.
- B. Adhesives: Armstrong S-750 and as recommended by the manufacturer and in full compliance with California VOC regulations.
 - 1. Adhesives shall comply with VOC content limits defined by SCAQMD Rule 1168
- PART 3 |EXECUTION
- 3.01 EXAMINATION
 - A. Verify that surfaces are smooth and flat with maximum variation of 1/8 inch in 10 ft, and are ready to receive Work.
 - B. Prior to ordering resilient sheet flooring, conduct Calcium-Chloride Test Method in accordance with ASTM F1869 to verify that concrete floor slabs are dry with maximum moisture vapor emissions of 3 pounds per 1,000 square feet in 24 hours and that slabs exhibit negative alkalinity, carbonation or dusting. Apply the moisture test in four (4) different areas of each floor location, with at least one test for each 1,000 square feet of floor area.
 - C. Prior to ordering resilient flooring conduct Relative Humidity Test Method in accordance with ASTM F 2170 to verify relative humidity and surface pH in accordance with ASTM F710 of concrete floor slabs, the method
 - 1. Requires drilling holes at diameter not to exceed outside diameter of probe by more than 0.04 inch to depth equal to 40 percent of slab's thickness (elevated structural slab shall be tested at depth equal to 20 percent of slab thickness).
 - 2. Place probe to full depth of test hole, place cap over probe.
 - 3. Permit test site to acclimate, or equilibrate, for 72 hours prior to taking relative humidity readings.
 - 4. Remove cap and press button on the probe to obtain reading.
 - 5. Relative humidity readings for substrates receiving non-permeable flooring are 75 percent or lower.
 - 6. Testing shall require 3 tests in first 1,000 square feet, with one additional test per each additional 1,000 square feet of concrete slab surface.
 - 7. Alkalinity testing: follow procedures per ASTM F710, ranges shall not exceed those recommended by the flooring manufacturer.
 - D. Alkalinity Testing: Concrete floors shall be tested for alkalinity prior to the installation of resilient flooring. Levels of pH shall not exceed the written recommendations of the resilient flooring manufacturer or the adhesive manufacturer, or both.
 - E. Ordering of flooring materials and beginning of installation means acceptance of existing substrate and site conditions.

3.02 PREPARATION

- A. Note: For Modernization and Remodel Projects use this paragraph: Install Vapor Emission Treatment Systems per Section 09 05 61, where tests reveal presence of more than acceptable moisture level in accordance with Test Method ASTM F 1869 or ASTM F 2170
- B. Preparation of Floors Concrete substrate: Surfaces to receive tile shall be scraped of foreign deposits. Subfloor filler shall be applied to the extent necessary to bring all depressions smooth and level.
- C. Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes, feather edges and fill other defects with subfloor filler.
- D. Apply, trowel and float filler to leave a smooth, flat, hard surface, free of bumps or depressions of any size.
 - 1. Latex Underlayment Latex modified, Portland cement based formulation or approved by flooring manufacturer for applications indicated. Ardex SD-F or equal. Product that will not disintegrate from moisture, for floor areas less than 1/4 inch buildup. All products shall be 100 percent asbestos-free.
- E. Inspection After floor surface has been prepared as described above and before application of adhesive, contractor must notify Inspector on any evidence of possible moisture problems.
- F. Prohibit traffic from area until filler is cured.
- G. Vacuum clean substrate.
- H. Apply primer as recommended by the materials manufacturer.
- 3.03 INSTALLATION TILE MATERIAL
 - A. Install in accordance with manufacturers' instructions.
 - B. Mix tile from container to ensure shade variations are consistent.
 - C. Spread only enough adhesive to permit installation of materials before initial set.
 - D. Set flooring in place, press with heavy roller to attain full adhesion.
 - E. Lay flooring with joints parallel to building lines.
 - F. Install tile to square grid pattern with all joints aligned, with pattern grain alternating with adjacent unit to produce basket weave pattern. Allow minimum 1/2 full size tile width at room or area perimeter, where possible.
 - G. Terminate flooring at centerline of door at door openings where adjacent floor finish is dissimilar.
 - H. Install edge strips at unprotected or exposed edges, and where flooring terminates.

- I. Scribe flooring to walls, columns, cabinets, floor outlets and other appurtenances to produce tight joints.
- J. Install flooring under movable partitions and under open cabinets without interrupting floor pattern.
- K. Install edge strips where flooring does not terminate at walls and where indicated. Fit joints tightly.
- L. Install wall base in accordance with Section 09 65 13.
- M. Installation of Vinyl Composition Tile Shall meet manufacturer's written installation specifications and industry standards. Finish product shall have tiles of equal width at opposite edges of room. Avoid cut widths that equal less than one-half of a tile at the perimeter. Tiles, when cut, shall butt neatly and tightly to vertical surfaces and permanent fixtures, including edgings, thresholds and nosing.
- N. Installation of Cove Base Install after floor tile is in place. Edges to align top and bottom, and joints to fit tight.
- O. Installation of Reducers, Transitions or Edging Strips Provide at all edges not covered by trim and at wall openings where abutting other finish flooring. Where doors occur, center edging strip below center of door.
- P. Final Inspection Prior to final inspection the contractor shall clean up the job site and remove all rubbish and debris. Remove excess adhesive from floor, base, and wall surfaces. Floors are to be cleaned and readied for the appropriate finish.
- 3.04 PROTECTION
 - A. Prohibit traffic on floor finish for 48 hours after installation.
 - B. Apply protective floor polish to floor surfaces that are free from soil, visible adhesive, and surface blemishes.
 - C. Cover products installed on floor surfaces with undyed, untreated building paper until final inspection.
 - D. Use of dollies with boards underneath whenever normally stationary equipment and/or furnishings must be moved across the floor.
 - E. Protect floors from rolling loads for 72 hours after installation by covering with hardboard or plywood.
- 3.05 CLEANING
 - A. Remove excess adhesive from floor, base and wall surfaces without damage.
 - B. Maintenance immediately after installation.
 - 1. Sweep or vacuum floor thoroughly.

- 2. Damp mop with a solution of a neutral detergent such as Armstrong S-485 Floor Cleaner, carefully wiping up black marks, use a scrubbing pad or brush as recommended for the type of floor being maintained.
- 3. When the floor is thoroughly cleaned, rinsed and dried, apply two coats of sealer equal to Armstrong S-495 Floor Sealer followed by four coats of a high-quality commercial floor polish equal to Armstrong S-480 Floor Polish (except on Step Master). Allow 8 hours drying time between coats of sealer and finish. Do not allow traffic on the floor for minimum 8 hours.
- 4. After the last coat of floor finish has dried sufficiently according to the manufacturer's instructions, burnish work, using high speed equipment, in accordance with manufacturer's written instructions to bring the entire surface, including the corners and edges, to high level of luster, free of all types of marks and dust embedded in finish.
- 5. Clean adjacent baseboard and other surfaces of adhesive and other materials. Replace damaged or defective Work to the specified condition.
- 6. Do not wash, scrub or strip the floor for at least four to five days after installation.
- C. Protection: Cover Work with a heavy non-asphaltic non-staining type building paper where subsequent building operations occur. Protect Work until completion. Repair or make good any damage to this Work and other materials damaged during installation of flooring.

END OF SECTION

SECTION 09 90 00

PAINTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Fluid applied paints and coatings. Upon completion of Work, all visible interior and exterior surfaces, within the Contract limits shall be painted unless scheduled "Not to Be Painted in this Section."
 - 1. Each paint system includes:
 - a. Surface preparation, including touch-up of shop applied primers, if needed.
 - b. Prime coat application, where scheduled as part of finish system.
 - c. Finish coat application, where scheduled apply two or more finish coats.
 - 2. Paint semi-concealed areas (e.g. inside of light troughs and valances, behind grilles, and projecting edges above and below sight lines, behind wall-mounted items).
 - 3. Repair and Painting of existing surfaces.
 - 4. Surface preparation and repair of surfaces treated for lead-based paint abatement work.
- B. Surfaces Not to be Painted:
 - 1. Prefinished wall, ceiling, and floor coverings.
 - 2. Items with factory-applied final finish.
 - 3. Concealed ducts, pipes, and conduit.
 - 4. Glass, plastic laminate, ceramic tile, anodized aluminum.
 - 5. Surfaces of steel items that will be embedded in concrete.
 - 6. Surfaces specifically scheduled or noted on the Drawings not to be painted.
 - 7. Fire-Rating labels on doors and frames.
 - 8. Performance labels on doors and frames.
- C. Related Sections:
 - 1. Section 09 01 90, Repair and Painting Existing Previously Painted Surfaces.
 - 2. Refer to drawings for finish schedule

1.02 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. ASTM International American Society for Testing and Materials
 - 1. ASTM D 4442 Direct Moisture Content Measurement of Wood and Wood-Base Materials.
 - 2. ASTM D 4444 Use and Calibration of Hand-Held Moisture Meters.
 - 3. ASTM D 6386 Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
- C. AQMD Air Quality Management District: AQMD Regulations Local Regulations

- D. SCAQMD South Coast Air Quality Management District: SCAQMD-1113 Rule 1113, Architectural Coatings.
- E. SDAPCD San Diego County Air Pollution Control District, Regulation IV.
- F. SSPC Steel Structures Painting Council.
- 1.03 SUBMITTALS
 - A. Product Data: For each paint system product and accessory item.
 - B. Samples: Of each specified finish system color, texture, and sheen; samples shall be minimum 8-1/2 by 11 inches in size.
 1 Propare transport wood finish samples on type and quality of wood specified
 - 1. Prepare transparent wood finish samples on type and quality of wood specified.
 - C. Certified copies of moisture test results.
 - D. Informational Submittals:
 - 1. Statement of Qualifications from manufacturer.
 - 2. Statement of Qualifications from installer.
 - 3. Manufacturer's application instructions.
 - E. Closeout Submittals
 - 1. Material Safety Data Sheets.
 - F. Submit Qualifications data for manufacturer and applicator under Quality Assurance.
- 1.04 MAINTENANCE MATERIALS AND SUBMITTALS
 - A. For each color, type, and gloss of paint used in the work provide, as Extra Materials, a quantity equal to approximately 10 percent of the quantity required for its installation rounded to the nearest gallon, or five gallons, whichever is less.
 - 1. Extra Materials shall be from the same production run as installed materials.
 - 2. Label each container with locations and dates of related installations; do not obscure manufacturer's label.
 - 3. Deliver Extra Materials to Site as directed by Owner.
- 1.05 QUALITY ASSURANCE
 - A. Manufacturer's Qualifications: Company with minimum 10-years' experience manufacturing quality paint and finish products for commercial projects similar in scale and complexity to those required for this Project.
 - B. Applicator Qualifications: Company with minimum 5-years' experience painting and finishing commercial projects similar in scale and complexity to those required for this Project.

- C. Painter Qualifications: Professional painter with minimum 5-years' experience for commercial projects similar in scale and complexity (comparable) to those required for this Project. Submit list of at least 5 comparable projects that are more than 2-years old together with names and telephone numbers of knowledgeable client contacts.
- D. Materials, for each paint system, shall be by, or as recommended by, a single coating manufacturer for use together in commercial quality paint / coating system for the substrate and exposure conditions indicated.
- E. Regulatory Requirements
 - 1. Conform to AQMD Regulations for maximum VOC limits. Conform to SCAQMD-1113 for maximum VOC limits.
 - 2. Comply with applicable codes and regulations of authorities having jurisdiction including those with jurisdiction over airborne emissions and industrial waste disposal. Where those requirements conflict with this Specification, comply with the more stringent provisions.
- F. Field Samples: Provide Field Sample of each finish system color, texture, and sheen scheduled. Do not proceed with coating application until sample panel has been approved.
 - 1. Field Sample shall be full height of wall by 10-feet.
 - 2. Locate as approved by Architect.
 - 3. Adjust materials and methods of installation as required to obtain Architect's approval.
 - 4. Document materials and methods used to obtain Architect's approval and maintain at least one copy of this documentation on site while related work is in progress.
 - 5. Maintain access to and protect Field Sample from damage while related work is in progress.
 - 6. Upon acceptance of related work, approved sample may remain as part of Work.
- G. Certifications.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site in their original, sealed, undamaged containers with labels intact and legible.
 - 1. Labels shall include manufacturer's name, type of paint, brand name, brand code, color designation, recommended surface preparation, typical coverage, drying times, cleanup procedures, and instructions for mixing and reducing, if permitted.
- B. Store paint materials ambient temperatures between 45- and 90-degrees F, in well ventilated area unless permitted otherwise by manufacturer's instructions.
- C. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.07 FIELD CONDITIONS

- A. Supply continuous ventilation and heating facilities to maintain surface and ambient temperatures above 45-degrees F for 24-hours before, during and 48-hours after application of finishes, unless permitted otherwise by manufacturer's instructions.
- B. Do not apply exterior coatings during rain, or when relative humidity is above 50 percent, unless permitted otherwise by manufacturer's instructions.
- C. Minimum application temperatures for Latex Paints: 45-degrees F for interiors; 50-degrees F for exterior; unless required otherwise by manufacturer's instructions.
- D. Minimum application temperature for Varnish and Transparent Finishes: 65-degrees F for interior or exterior, unless permitted otherwise by manufacturer's instructions.
- E. Maintain lighting level sufficient to conduct painting operations.
- 1.08 GUARANTEE
 - A. Guarantee the painting Work against peeling, fading, cracking, blistering or crazing for a period of two years form the Date of Certified Completion for painting of new surfaces and existing surfaces.
- PART 2 PRODUCTS
- 2.01 PAINTS AND COATINGS
 - A. Acceptable Manufacturers: Products of following manufacturers form basis for design and quality intended.
 - 1. Sherwin-Williams Company, Cleveland OH
 - 2. Vista Paint Corporation, Fullerton, CA.
 - 3. Behr Process Corporation, Santa Ana, CA.
 - 4. Dunn-Edwards Corporation, Los Angeles, CA.
 - 5. Kelly-Moore Paint Company Inc., San Carlos, CA.
 - 6. PPG Industries Inc., Pittsburg, PA.
 - 7. Tnemec Company Inc., Kansas City, MO.
 - 8. Genesis Coatings, Vista, CA.
 - 9. Monopole Inc., Glendale, CA.
 - 10. Carboline Company, St. Louis, MO.
 - 11. Rust-Oleum Corporation, Somerset, NJ.
 - 12. Goo Systems, Kingston, ON.
 - 13. Benjamin Moore and Co., Montvale, NJ.
 - 14. McCloskey, Wheeling, IL.
 - 15. Cabot, Newburyport, MA.
 - 16. Minmax Company, Upper Saddle River, NJ.
 - 17. The Valspar Corporation
 - B. Or equal, approved in accordance with Division 01, General Requirements, for substitutions.

2.02 MATERIALS

- A. Coatings: Ready mixed, except field-catalyzed coatings. Process pigments to soft past consistency, capable of being readily and uniformly dispersed to homogenous coating.
- B. Colors and Glosses: As scheduled in Section 09 06 00. Architect will select color and hue to be used in various types of paint specified and will be sole judge of acceptability of various glosses obtained from materials proposed to be used in Work. During actual painting, Architect may make minor modifications in tone and shade to adjust for actual surface and lighting conditions encountered.
- C. Undercoats and Thinners: Provide undercoat paint produced by same manufacturer as finish coat. Use only thinners recommended by paint manufacturer and use only to recommended limits. Use undercoat, finish coat and thinner material as parts of a unified system of paint finish.
- D. Coatings: Good flow and brushing properties; capable of drying or curing free of streaks or sags.
- E. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified of commercial quality.
- 2.03 APPLICATION EQUIPMENT
 - A. For application of the approved paint, use only such equipment as is recommended by the manufacturer.
 - B. Compatibility: Prior to actual use of application equipment, use all means necessary to verify that the proposed equipment is actually compatible with the material to be applied and that the integrity of the finish will not be jeopardized by the use of the proposed application equipment.
- 2.04 FINISHES
 - A. Refer to schedule at end of Section for surface finish and Section 09 06 00. Notwithstanding product numbers listed in schedule, Contractor shall conform to most recent product numbers as published by the manufacturer.
- PART 3 EXECUTION
- 3.01 INSPECTION
 - A. Verify that surfaces are ready to receive Work as instructed by the product manufacturer.
 - B. Examine surfaces scheduled to be finished prior to commencement of Work. Report any condition that may potentially affect proper application.

- C. Measure moisture content of new surfaces using an electronic moisture meter. Apply finishes only when moisture content of surfaces are below the following maximums. Conduct moisture measurements in presence of the project inspector, document readings and submit to Architect under Part 1.
 - 1. Plaster and Gypsum Wallboard: 12 percent.
 - 2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
- D. Beginning installation means acceptance of existing surfaces and conditions.

3.02 MATERIALS PREPARATION

- A. Mix and prepare painting material in accordance with manufacturer's recommendations.
- B. Store materials not in actual use in tightly covered containers.
- C. Maintain containers used in storage, mixing and application of paint in a clean condition, free from foreign materials and residue.
- D. Stir all materials before application to produce a mixture of uniform density and as required during the application of materials. Do not stir into the material any film that may form on the surface. Remove the film and strain the material before using.
- 3.03 SURFACE PREPARATION
 - A. Remove electrical plates, hardware, light fixture trim and fittings prior to preparing surfaces for finishing.
 - B. Correct minor defects and clean surfaces which surfaces which affect Work of this section.
 - C. Shellac and seal marks that may bleed through surface finishes.
 - D. Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
 - E. Gypsum Board Surfaces: Fill minor defects, joints and nail head depressions with spackling compounds. Prime in accordance with primer manufacturer's recommendations. Apply primer over skim coat for Level 5 finish where Level 5 is indicated.
 - F. Plaster Surfaces: Fill hairline cracks, small holes and imperfections with patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
 - G. Surface Preparation for Exterior Metal (Except Galvanized): Preparation in accordance with SSPC-6 Commercial Blast Cleaning.
 - H. Galvanized Surfaces:

- 1. Prepare galvanized steel and nonferrous metal surfaces in accordance with ASTM D 6386-Surface Preparation of Galvanized Surfaces and manufacturer's instructions.
- 2. Ensure surfaces are dry.
- 3. Interior Exposure (Dry/Benign): Remove visible, oil, grease, dirt, dust, protective mill coatings, and other soluble contaminants in accordance with SSPC-SP 1 or manufacturer's instructions as specified for coating system. Hand or Power tool clean to remove all insoluble contaminants.
- 4. Interior and Exterior Exposure (moderate to severe): Remove visible oil, grease, dirt, dust, protective mill coatings, and other soluble contaminants in accordance with SSPC-SP 1 or manufacturer's instructions as specified for coating system. Follow initial cleaning with one of the following Methods:
 - a. SURFACE PREPARATION METHOD A (Preferred): Thoroughly roughen the entire surface to be coated using compressed air brush off blast cleaning with a fine abrasive to achieve a uniform anchor profile of 1-2 mils. reference ASTM D 6386-99 (2005) Section 5.4.1.
 - b. SURFACE PREPARATION METHOD B (Alternative method when Method A is not feasible): Chemically Treat with one of the following products to etch the galvanized surface to be coated: Henkel Galvaprep 5 or Clean & Etch by Great Lakes Laboratory. Reference ASTM D 6386-99 (2005) Section 5.4.2.
- I. Uncoated Steel and Iron Surfaces: Remove grease, scale, dirt and rust. Where heavy coatings of scale are evident, remove by wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime paint after repairs with Tnemec Series L69 Hi Build Epoxoline II or Carboline 890 VOC or approved in accordance with Division 01, General Requirements for Substitutions.
- J. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Spot prime bare steel surfaces to match existing primer.
- K. Previously Coated Surfaces: As required in Section 09 01 90. Painting over existing painted surfaces interior and exterior, ascertain that new paint system is compatible with existing gloss and high-gloss oil based paint system to insure proper adhesion. Sand lightly existing paint and prime walls as scheduled.

3.04 PROTECTION

- A. Protect elements surrounding the Work of this Section from damage or disfiguration.
- B. Repair damage to other surfaces caused by Work of this Section.
- C. Furnish drop cloths, shields and protective methods to prevent spray or droppings from disfiguring other surfaces.
- D. Remove empty paint containers from site.

3.05 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Do not apply finishes to surfaces that are not dry.
- C. Apply each coat to uniform finish. Number of coats specified is a minimum. Additional coats shall be applied at no extra cost, if coatings show evidence of uneven application, uneven pigmentation, brush strokes or otherwise unsatisfactory distribution of material.
- D. Under coats shall be lighter and brighter in tint that finish coat.
- E. Sand lightly between coats to achieve required finish.
- F. Allow applied coat to dry before next coat is applied.
- G. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- H. Seal tops, bottoms and cutouts for hardware and accessories of wood doors and plastic-laminate covered doors.
- I. Paint finish shall continue through behind all wall-mounted items (e.g. markerboards, chalk and tack boards).

3.06 CLEANING

- A. As Work proceeds, promptly remove paint where spilled, splashed, or spattered.
- B. During progress of Work maintain premises free of unnecessary accumulation of tools, equipment, surplus materials and debris.
- C. Collect cotton waste, cloths, and material that may constitute a fire hazard, place in closed metal containers and remove daily from site.

3.07 FINISH SYSTEM SCHEDULE - EXTERIOR EXPOSURE

			Vista	Behr	Dunn- Edwards		Sherwin- Williams		Kelly- Moore PPG	
A.	Ferr 1. 2. 3.	ous - Flat - Acrylic Primer, 1 Coat9600 Tie Coat 1 Coat Finish, 1 Coat 2200	436 2200 610	43-5 610 SSHL	B66-3 SSHL 10	10 10 A6	5725 A6 1240	4020 1240 4020	4020	
В.	Ferr 1.	rous - Semi-Gloss - Acı Primer, 1 Coat9600	rylic 436	BRPR	00	B66	5725	4020		
	1 100									

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	2. 3.	Tie Coat, 1 Coat Finish, 1 Coat 9800	9800 670	670 SSHL5	SSHL: 50	50 B53Z	B53Z 5885	5885 4216	4216
C.	Ferro 1. 2.	ous - Gloss - VOC Cor Primer, 1 Coat9600 Finish, 2 Coats	npliant 436 9900	BRPR(8200	00 10W	B66-31 B54Z	10 1980	5725 4208	4020
D.	Ferro touch	ous - Factory Primed. n-up prime coat in lieu	lf shop of full p	primer rimer co	is comp bat ther	oatible v n apply p	vith finis Daint fin	sh mate ish as s	rials, clean and pecified.
E.	Galv 1.	anized Steel and Alum Surface Prep Krud Kutter	ninum - Krud Kutter	Flat - Ao GE-12	crylic 3	B71Y1	Jasco P&P	Devpre 88	эр
	2. 3.	Primer, 1 Coat4800 Finish, 2 Coats	436 9800	GAPR 610	00 SSHL ²	B66W ² 10	1 A6	5725 1240	4020 4020
F.	Galv	anized Steel and Alum	ninum -	Gloss -	voc c	ompliar	it		
	1.	Surface Prep Jasco P&P	Krud Kutter	GE-12	3	(Not R	eq.)	Jasco P&P	Devprep 88
	2. 3.	Primer, 1 Coat 4800 Finish, 2 Coats	436 9900	GAPR 8200	00 10 Sei	B66-31 ries	0 B54Z	5725 1980	4020 4028
G.	Galv	anized Steel and Alum	ninum -	Semi-G	loss - A	crvlic			
	1.	Surface Prep Krud Kutter	Krud Kutter	GE123	Jasco P&P	Jasco P&P	Devpre 88	ер	
	2. 3.	Primer, 1 Coat4800 Finish, 2 Coats Bulls Eye 12	436 7000 Adhes 23	GAPR 670 ion 2111	00 W7500	B66-31 DB31W	10 J8651	5725	4020 4216L

3.08 FINISH SYSTEM SCHEDULE - INTERIOR SURFACES

Dunn- Sherwin- Kelly-Vista Behr Edwards Williams Moore PPG

A.	Gypsum Board - Flat - Acrylic (Skim Coat required for Level 5 finish)									
	1.	Primer, 1 Coat1100	73	W101\	/	B28W4	00	971	1000	
	2.	Finish, 2 Coats	5100	310	W420	B30W2	00	550	1201V	
В.	Gypsum Board - Eggshell - Acrylic (Skim Coat required for Level 5 finish)									
	1.	Primer, 1 Coat1100	73	W101\	/	B28W4	00	971	1000	
	2.	Tie Coat, 1 Coat	5300	330	W420	B31W2	00	A1610	1403V	
	3.	Finish, 2 Coats	5300	330	W411\	/	B31W2	200	A1610	1403V
C.	Gyps	sum Board - Semi-Glos	ss - Acr	ylic (Ski	m Coat	require	d for Le	vel 5 fir	nish)	
	1.	Primer, 1 Coat1100	73	W101\	/	B28W4	00	971	1000	
	2.	Finish, 2 Coats	5400	370	W7500)B31W2	00	1650	1407V	
D.	Gyps	Gypsum Board - Gloss - Acrylic (Skim Coat required for Level 5 finish)								
			÷ o	144041	, .	DOOLA	~~	~~ · `	4000	

1. Primer, 1 Coat 1100 73 W101V B28W400 971 1000
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	2. 3.	Tie Coat, 1 Coat Finish, 2 Coats	5400 5400	2-8050 2-8050	EVSH6	60 60	B21 B21	1680 1680	3028N 3028N
E.	Ferro 1. 2. 3.	ous - Flat - Acrylic Primer, 1 Coat9600 Tie Coat, 1 Coat Finish, 1 Coat 5100	436 5100 310	43-5 310 W401	B66-31 W401 B30-60	10 B30-60)0	5725)0 550	4020 550 4020	4020
F.	Ferro 1. 2. 3.	ous - Semi-Gloss - Acr Primer, 1 Coat9600 Tie Coat, 1 Coat Finish, 1 Coat 5400	ylic 436 5400 370	43-5 370 W7500	B66 W7500)B31-60	5725)B31-60)0	4020)0 5885	5885 4216L	4216L
G.	Ferro 1. 2. 3.	ous - Gloss - Acrylic Primer, 1 Coat9600 Tie Coat, 1 Coat Finish, 1 Coat 5400	436 9600 2-8050	43-5 2-8050 W7600	B66-31 W7600)B21	10)B21 1680	5725 1680 3028N	4020 3028N	
H.	Ferro toucl	ous - Factory Primed. I h-up prime coat then a Kutter	f shop µ pply Fin Kutter	orimer is hish as s	s compa schedule	atible wi ed. SP1	ith sche P&P	eduled fi 88	inish, clean and
I.	Galv 1. 2. 3. 4.	anized and Aluminum Surface Prep Krud Kutter Primer, 1 Coat 4800 Finish, 2 Coats Finish, 2 Coats (Stain	- Semi- Krud Kutter 436 5400 less Ste	Gloss - SCME UGPR 370 eel)	Acrylic -01 00 W7500 SZRO5	SSPC- SP1 B66-31)B31W, 50	Jasco P&P I0 J8651	Devpre 88 5725 5885	ep 4020
J.	Galv 1. 2. 3. 4. 5.	anized and Aluminum Surface Prep Krud Kutter Primer, 1 Coat4800 Finish, 2 Coats Finish, 2 Coats (Stain	- Gloss Krud Kutter 436 5400 less Ste	- Acryli SCME UGPR 2-8050 eel)	c -01 00 W7500 SZRO0	SSPC- SP1 B66-31)B21W.)50	Jasco P&P 10 J8651	Devpre 88 5725 1680	ep 4020 3028N
3.09			SPECI	AL CO	ATING S	SYSTEI	MS		
Δ	Plae	ter Drywall Wood Co	ncrete	- Vanor	Barrior	Primo	/Sealer	íf usa	d substitute for

- A. Plaster, Drywall, Wood, Concrete Vapor Barrier Primer/Sealer (if used, substitute for scheduled primer, then apply Finish specified.)
 - 1. Benjamin Moore, Moorcraft SuperSpec Latex Vapor Barrier Sealer 260
 - 2. Sherwin-Williams, Interior Latex Moisture Vapor Barrier B72W1
 - 3. Vista Paint/Zinsser B-I-N Shellac Base Vapor Barrier
 - 4. PPG, Vapor Barrier Primer 1060-1200
- B. Steel, Galvanized Metal, Concrete Gloss Epoxy Mastic Low VOC
 - 1. Primer, 1 Coat
 - 2. Finish, 2 Coats
 - a. Rust-Oleum, V9100 System DTM epoxy mastic
 - b. Behr, Jotun Jotamastic SF (VOC 55 g/L)

C. Special Coatings: Exterior; metal handrails, railings, guardrails, ornamental metal fences and gates. Total 5.0 to 8.5 mil thickness, as recommended by the manufacturer.

				PPG Tnemec		Sherwin- Williams		Carboline		PPG	
	1. Unprimed or shop primed - Ferrous - Gloss - Polyurethane										
		a.	Primer, 1 Coat	Amero 385	coat	L69	B58-62	20	Carbomastic 15		203V
		b.	Finish, 2 Coats	Ameri	shield	1080	B65-62	25	Carbothane 134 MC		379H
	2.	Unprimed or shop primed - Ferrous - Semi-Gloss - Polyurethane									
		a. [.]	Primer, 1 Coat		L69	B58-6	8-620 Cai 89(guard CC	203V	
		b.	Finish, 2 Coats		1081	B65-6	B65-625		hane 378H C		
	3.	Galvanized or Aluminum - Gloss - Polyurethane									
		a.	Primer, 1 Coat	Amerl 400	ock	L69	B58-62	20	Galos WB	eal	203V
		b.	Finish, 2 Coats	Ameri	shield	1080	1080 B65-62		25 Carbotha 34 MC		379H
	4.	Galvanized or Aluminum - Semi-Gloss - Polyurethane									
		a.	Primer, 1 Coat		L69	B58-620 B65-625		Carbo 90 VO	arboguard		
		b.	Finish, 2 Coats		1081			Carbothane 33 MC		378H	
D.	Galvanized - Gloss - Polyurethane - salt air, moisture environment										
	1.	. Primer, 1 Coat, 5 mils minimum DFT									
		a.	Sherwin-Williams, Macropoxy 646								
	c. PPG Bar-Rust 231K or Devran 203V										
		d.	Tnemec, L69 Er	nemec, L69 Epoxoline							
	2.	Finish, 2 Coats, 7 mils minimum DFT									

- a. Sherwin-Williams, Hi-Solids Polyurethane
- b. Carbothane, 134 MC (distributed by Vista)
- c. PPG, Devthane 379H
- d. Tnemec, 1080 WB Endura-Shield
- E. Unprimed Metal, Surface Preparation: SSPC-SP3, Power Tool Cleaning
- F. Galvanized Metal, Surface Preparation: SSPC-SP1, Solvent Wash, and etch with one of the following:
 - 1. Sherwin-Williams, GLL Clean N Etch
 - 2. Dunn-Edwards, Galva-Etch (GE123)
 - 3. Vista: Krud Kutter Metal Etch
 - 4. Devoe, Devprep 88

$H\!M\!C_{\text{Architects}}$

5. Or equal

SECTION 10 11 16

MARKERBOARDS

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Markerboards, dry-erase, magnetic.
 - B. Trim, chalkrail and accessories.
 - C. Related Section(s):1. Refer to drawings for finish schedule
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ASTM B209 Aluminum-Alloy Sheet and Plate.
 - C. ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - D. ASTM B221 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
 - E. PEI Porcelain Enamel Institute Performance Specifications for Porcelain Enamel Markerboards.
 - F. ASTM A424 Sheet Steel for Porcelain Enameling.
 - G. ANSI A208.1 Mat Formed Wood Particleboard.
- 1.03 SUBMITTALS
 - A. Shop drawings indicating, wall elevations, sizes, dimensions and joint locations between panels, and mounting details.
 - B. Provide product data on trim and accessories.
 - C. Three samples illustrating materials and finish, color and texture of markerboard.
 - D. Include maintenance information on regular cleaning, stain removal and removal of damaged components.

1.04 WARRANTY

- A. General Warranty: Special Markerboard warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.
- B. Markerboard Warranty: Submit written warranty executed by manufacturer agreeing to replace porcelain-on-steel markerboards that do not retain their original writing and erasing qualities, become slick and shiny, or exhibit crazing, cracking, or flaking within specified warranty period, provided manufacturer's written instructions for handling, installation, protection, and maintenance have been followed.
- C. Warranty Period: Life of building.
- PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Products of following manufacturers form basis for design and quality intended.
 - 1. Platinum Visual Systems/ABC School Equipment, Inc., Corona, CA.
 - 2. Egan Visual, Inc./The Scheffey Group, Los Angeles, CA.
 - 3. ADP Lemco Inc., Salt Lake City, UT.
 - 4. Marsh Industries, New Philadelphia, OH.
- B. Or equal as approved in accordance with Division 01, General Requirements for Substitutions.
- 2.02 MATERIALS
 - A. Sheet Steel: ASTM A424, minimum 28 gauge
 - 1. Can support papers by means of magnets with Dry-erase qualities. Quantities of magnets: As required by Architect.
 - 2. Color: white
 - 3. Models: Steelcase; CEDM 084, 96"W x 48"H
 - B. Sheet Steel: ASTM A653, galvanized to G60 designation.
 - C. Aluminum Sheet: ASTM B209, H1100 Alloy H-19 temper
 - D. Aluminum Extrusions: ASTM B221, 6061 alloy, T5 temper
 - E. Particle Board: ANSI A208.1; wood chips or shavings set with waterproof resin binder, sanded faces.
 - F. Adhesives: Type recommended by manufacturer. Waterproof type.
- 2.03 ACCESSORIES
 - A. Map Supports: Formed aluminum roller brackets, sliding type to fit map rail.

- B. Provide instructions for markerboard cleaning.
- C. Manufacturer's standard support clip , hangers, and accessories for markerboards to function properly.
- 2.04 FABRICATION MARKERBOARDS
 - A. Outer Face Sheet: Platinum Visual Systems Writanium, ASTM A424, steel, 0.0150" thick, with vitreous porcelain enamel finish, primer, ground and cover coat. Markerboards 16 feet and wider: 0.0240" thick and routed steel splined joint.
 - B. Core: ANSI A208.1, particleboard; 1/2 inch thick Industrial Grade M2.
 - C. Backing Surface: ASTM B209, aluminum sheet, 0.015 inch thick, or ASTM A653, 26 gauge galvanized steel.
 - D. Sizes: Refer to Drawings for sizes, locations and quantities.
 - E. Frame: aluminum frame .
- 2.05 FRAME AND TRIM
 - A. Frame: Extruded aluminum; Platinum Visual Systems STS SERIES Series except with 0.015" aluminum backing, concealed fasteners :
 - 1. Display (map) Rail: 2 inch, with natural cork insert, 1/4" thick, with vinyl covering, full length of markerboard. Vinyl to match tackboard vinyl.
 - 2. Head and Side Trims: C-18, 1-1/2" aluminum trim, 0.062", clear anodized.
 - 3. Mullion Trim at markerboards 16' and wider: Butt joints, routed steel splined joints.
 - B. Marker tray: Platinum Visual Systems, blade profile marker tray, extruded aluminum, full length of markerboard, solid sections with smooth curved ends, concealed fasteners.
 - C. Provide 1 each map hook every 2 linear ft of maprail and two roller brackets for each markerboard unit. One flag holder per room.
- 2.06 FINISHES
 - A. Porcelain Enamel: Glass fired enamel in accordance with PEI Type A. Color as selected from manufacturer's standard range.
 - B. Aluminum Frame and Accessories: Anodized to clear natural finish.
- PART 3 EXECUTION
- 3.01 INSPECTION
 - A. Verify that surfaces and internal wall blocking are ready to receive Work and dimensions are as indicated on shop drawings.

B. Beginning of installation means acceptance of substrate construction.

3.02 INSTALLATION

- A. Install markerboards in accordance with manufacturer's instructions.
- B. Establish bottom of frame perimeter at 24 inches for Kindergarten (26 inches 1st to 3rd Grades), (30 inches 4th to 6th Grade) (34 inches 7th to 9th Grades) (37 inches 10th Grade and higher) above finished floor or as approved by Architect.
- C. Secure units level and plumb.
- D. Where markerboard adjoins tackboard or chalkboard, join panels with H/Bar divider joint.
- E. NO holes in markerboard permitted.
- 3.03 CLEANING
 - A. Clean markerboard surfaces and aluminum in accordance with manufacturer's instructions.
 - B. Cover markerboard surfaces with clear protective covering.
 - C. Remove protective cover at Date of Notice of Completion.

SECTION 10 14 00

IDENTIFICATION SIGNS

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Plastic Signs, raised character, tactile, room identification, exit door signs, and non-tactile signs.
- 1.02 REFERENCE STANDARDS
 - A. Conform to reference standards by date of issue current on date of Contract Documents.
 - B. American Society for Testing and Materials (ASTM)
 1. ASTM D4802 Poly (Methyl Methacrylate) Acrylic Plastic Sheet
 - C. ADA Americans with Disabilities Act of 1990 as amended.
 1. ADA/Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design.
 - D. CBC 2016 California Building Code (CBC)
 - 1. CBC 16 Chapter 10, Egress Requirements
 - 2. CBC 11B Chapter 11B, Accessibility for Public Buildings, Public Accommodations, Commercial Facilities and Publicly Funded Housing
 - E. CFC 2016 California Fire Code.
 - F. California Code of Regulations (CCR)1. CCR 19-3 Title 19, Chapter 3
 - G. Fed.Stnd Federal Standard1. Fed.Stnd 595C, Colors Used in Federal Procurement
- 1.03 SUBMITTALS
 - A. Shop Drawings of each sign, indicating lettering styles and locations and overall dimensions.
 - B. Three sample, full size, signs, of types, styles and colors specified including method of mounting. If accepted, samples may be installed in Project.
 - C. Manufacturer's Installation Instructions
 - D. Lettering Samples: 1-inch high, uppercase I, and O letters in each font specified, for required Quality Assurance testing.

1.04 QUALITY ASSURANCE

- A. Pre-Installation Conference
 - 1. Notify Architect when signs are ready for installation. Arrange for conference at site. Do not proceed with installation until Architect's approval of specific locations and methods of attachment has been obtained.
 - 2. Provide signs from one manufacturer, unless otherwise approved.
- 1.05 DELIVERY, STORAGE AND HANDLING
 - A. Deliver products to site and protect from damage. Store until immediately prior to Notice of Completion.
- PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Signage and Graphics:
 - 1. Raised characters shall comply with CBC Section 11B-703.2
 - a. Depth: It shall be 1/32-inch minimum above their background and shall be sans serif uppercase and be duplicated in Braille.
 - b. Height: It shall be 5/8-inch minimum and 2 inches maximum based on the height of the uppercase letter "I". CBC Section 11B-703.2.5.
 - c. Finish and contrast: Characters and their background shall have a non-glare finish. Character shall contrast with their background with either light characters on a dark background or dark characters on a light background. CBC Section 11B-703.5.1
 - d. Proportions: It shall be selected from fonts where the width of the uppercase letter "O" is 60% minimum and 110% maximum of the height of the uppercase letter "I". Stroke thickness of the uppercase letter "I" shall be 15% maximum of the height of the character. CBC Section 11B-703.2.4 and 11B-703.2.6.
 - e. Character Spacing: Spacing between individual raised characters shall comply with CBC Section 11B-703.2.7 and 11B-703.2.8.
 - f. Format: Text shall be in a horizontal format. CBC Section 11B-703.2.9.
 - g. Braille: It shall be contracted (Grade 2) and shall comply with CBC Sections 11B-703.3 and 11B-703.4. Braille dots shall have a domed or rounded shape and shall comply with CBC Table and Figure 11B-703.3.1.
 - h. Mounting height: Tactile characters on signs shall be located 48" minimum to the baseline of the lowest Braille cells and 60" maximum to the baseline of the highest line of raised characters above the finish floor or ground surface. CBC Section and Figure 11B-703.3.4.1.
 - i. Mounting location: A tactile sign shall be located per CBC Section and Figure 11B-703.4.2 as follows:
 - 1) Alongside a single door at the latch side.
 - 2) On the inactive leaf at double doors with one active leaf.
 - 3) To the right of the right hand door at double doors with two active leafs.



- 4) On the nearest adjacent wall where there is no wall space at the latch side of a single door or at the right side of double doors with two active leafs.
- 5) So that a clear floor space of 18" x 18" minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position.
- 2. Visual characters shall comply with CBC Section 11B-703.5 and shall be 40" minimum above finish floor or ground.
- 3. Pictograms shall comply with CBC Section 11B-703.6.
- 4. Symbols of accessibility shall comply with CBC Section 11B-703.7.
- 5. Variable message signs shall comply with CBC Section 11B-703.8.

2.02 MANUFACTURERS

- A. Products of following manufacturers form basis for design and quality intended.
 - 1. All Star Signs, Escondido, CA
 - 2. Apco Signs, Atlanta, GA.
- B. Or approved equal in accordance with Division 01 General Requirements for substitutions.
- 2.03 PLASTIC SIGN MATERIALS
 - A. Tactile Plastic Sign Materials: Thermosetting high pressure laminate.
 - B. Non-Tactile Signs: Acrylic Plastic Sheet: ASTM D4802, Category A-1, 1/4 inch overall thickness, laminated acrylic plastic sheets.
- 2.04 SIGN FABRICATION GENERAL
 - A. Plastic Signs
 - 1. Equal to APCO IM System modular updatable plaque signage system consisting of holder unit mounted to substrate and insert panels secured to holder providing graphic and visual information.
 - 2. Director Interchangeable Message Panels Sign Track:
 - a. Combination of radius header and base holder units, with vertical aluminum tracks to accept Preslock fastener, single or multiple centers, and base insert units to form modulating wall mounted directory.
 - b. Combination of two header and two base holder modules back to back with similar header and base insert units to form ceilings suspended module providing graphic and visual information.
 - c. Combination of components including six aluminum extruded profiles Square Bevel Large Radius Large Bevel EdgeOut ThinLine sized molded IM inserts or custom inserts. Corner key assembly for Square and Radius Corner formats. PresLock attachment devices for retaining insert material.
 - 3. Informer: Combination of holder unit mounted to substrate and insert panel allowing use of panel as magnetic bulletin board or poster holder, directory, emergency plan, or LetterGrip holder secured to holder.
 - 4. Materials
 - a. Holder:

- 1) Material: Integrally colored injection molded high impact UV resistant, colorfast, plastic alloy complete with mounting system; ready for insert installaion.
- 2) Corners: Radius or Square corners indicated in drawings.
- 3) Edge Detail: Bevel Edge
- b. Mounting
 - 1) Surface: Wall or Vertical Surface. Ceiling. Desk. Indicated in dwgs.
 - 2) Fastening: MFH. VTM. PIN. WM. CM. Indicated in dwgs.
- c. Sizes: Indicated in dwgs.
- d. Color: Indicated in dwgs.
- 5. Insert
 - a. Non-Tactile Signs: Integrally colored injection molded high impact plastic with computer generated photographic silkscreen process surface printing chemically bonded to self-aligning reveal insert material; insert corner same type as holder
 - b. ADA tactile sings: 1/32" thickness computer generated photo-etched rubberized surface material chemically bonded to self-aligning reveal insert material; insert corner same type as holder.
 - c. ClearLens inserts are special configured molded inserts provided with same corner configuration as the molded holder. This insert allows graphic to be seen beneath surface.
- 6. Schedule:
 - a. Offices and Work Areas: Provide 2-1/2" x 6" graphic panel with raised room number and Braille dots for each door, with 3-1/2" x 6" in-house updateable module for each door.
 - b. Classrooms: Provide 2-1/2" x 6" graphic panel with raised room number and Braille dots with ad 6" x 6" in-house updateable module for each door.
 - c. Fire Exit Doors: In accordance with CBC
- 7. Attachment Material: As recommended by manufacturer to suit installation conditions, with consideration for potential of high abuse and for concealing fastenings.
- 8. Finishes: Custom colors and finishes per dwgs.
- Character (Letter and Number) Style: Characters as indicated on the Contract Drawings or, if not indicated, as selected by Architect. If not indicated, assume Helvetica Medium font for bidding. Lettering shall be raised minimum 1/32" above sign surface.
- 10. Braille: Refer to Paragraph regarding tactile exit signage.
- B. Accessible Exit Signage: Comply with the requirements of CBC
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Verify that surfaces are ready to receive Work.
 - B. Beginning of installation means installer accepts existing surfaces.
- 3.02 INSTALLATION
 - A. Install signs only after surfaces are finished, install at all rooms.

- At single-leaf doors, locate signs on wall adjacent to latch side of applicable door opening, centered horizontally within 18-inch space adjacent to latch side of door, 60 inches from finish floor to center line of sign. Mounting location shall be located so that a clear space of 18" minimum by minimum by 18" minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position. CBC Section 11B-703.4.2.
- B. Mounting
 - 1. Tactile Plastic Signs: Stainless steel screws, pin torx, vandal-proof.
 - 2. Non-tactile Plastic Signs:
 - a. Install with four (4) stainless steel countersunk flathead screws, pin torx, vandal-proof. Pre-drill holes to prevent breaking plastic, use countersunk drill bits to flush screw head with sign surface.
- C. For signs installed on glass: a blank vinyl backer is required to be placed on opposite side of glass exactly behind sign being installed. This blank glass back up is to be the same size as sign being installed.
- D. Clean and polish signs following manufacturer'¢s instructions.
- 3.03 FIELD QUALITY CONTROL
 - A. DSA Inspections: Signs and identifications or other information shall be field inspected after installation and approved by Division of the State Architect prior to the issuance of a final certificate of occupancy, or final approval where no certificate of occupancy is issued. The inspection shall include, but not limited to, verification that Braille dots and cells are properly spaced and the size, proportion and type of raised characters are in compliance with CBC, Section 11B-703.1.1.2.
- 3.04 SIGN TYPES AND SCHEDULE
 - A. As indicated on Drawings.

SECTION 10 14 33

EXIT SIGNAGE

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Self-Luminous Exit Signage.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ADA Americans with Disabilities Act of 1990
 - 1. ADA Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design.
 - C. CBC California Building Code, 2016.
 - D. UL 924 Emergency Lighting and Power Equipment.
- 1.03 SUBMITTALS
 - A. Shop drawings listing sign styles, lettering and locations and overall dimensions of each sign.
 - B. Two samples illustrating full size sample sign, of type, style and color specified including method of attachment. If accepted, samples may be installed in project.
 - C. Manufacturer's installation instructions.
- 1.04 QUALITY ASSURANCE
 - A. Regulatory Requirements for Tactile Exit Signs
 - 1. Conform to CBC for accessibility provisions, CBC 1011.4, 11B-703.1, 11B-703.2, 11B-703.3, 11B-703.4 and 11B-703.5.
 - 2. Signage Requirements
 - a. Character Proportions: Characters shall be selected from fonts where the width of the uppercase letter "O" is 60 percent minimum and 110 percent maximum of the height of the uppercase "I", 11B-703.2.4. Stroke thickness of the uppercase letter "I" shall be 15% maximum of the height of the character. All letters measured must be uppercase.
 - b. Line Spacing: Spacing between the baselines of separate lines of raised characters within a message shall be 135% minimum and 170% maximum of the raised character height.



- c. Finish and contrast: Characters and their background shall have a non-glare finish. Characters shall contrast with their background, with either light characters on a dark background or dark characters on a light background, 11B-703.5.1.
- d. Characters and symbols shall contrast in color or image with either light letters on dark background or dark letters on light background, and shall be raised minimum 1/32 inch.
- e. Minimum height for raised characters or symbols: 5/8 inch minimum and 2 inches maximum, uppercase.
- f. Braille: California (Contracted) Grade 2 Braille. Dot base diameter shall be 0.059 inch to 0.063 inch. Dots shall be 0.100 inch on center in each cell with 0.300 inch space between corresponding dots in adjacent cells. Distance between corresponding dots from one cell directly below, 0.395 to 0.400 inch. Dots shall be raised 0.025 to 0.037 inch above the background. Braille dots shall be domed or rounded.
- B. Pre-installation Conference: Notify Architect when signs are ready for installation. Arrange for conference at site. Do not proceed with installation until Architect's approval of specific locations and methods of attachment has been obtained.
- 1.05 DELIVERY, STORAGE AND HANDLING
 - A. Deliver products to site and protect from damage. Store until immediately prior to Notice of Completion.
- PART 2 PRODUCTS
- 2.01 MANUFACTURERS
 - A. Products of following manufacturers form basis for design and quality intended.
 - 1. Evenlite, Bensalem, PA.
 - 2. Active Safety, Murray, UT
 - 3. Safe Glow Corp, Yorba Linda, CA
 - 4. Self-Powered Lighting Inc., Berwyn, PA
 - 5. Isolite Corporation, San Luis Obispo, CA
 - B. Or equal as approved in accordance with Division 01, General Requirements for substitutions.
- 2.02 REGULATORY REQUIREMENTS
 - A. Exit Sign shall be illuminated at all times.
 - B. Self-Luminous Signs: CBC Section 1011.5.
- 2.03 EMERGENCY EXIT SIGNS
 - A. Conform to CBC for accessibility provisions, CBC 1011.5.
 - B. Self-Luminous Exit Signs: UL 924 Listed, minimum luminance, 0.06 foot lambert. Non electric, internally illuminated by sealed tritium gas light source.



- 1. Surface Mounted Wall Signs:
 - a. Low and High Level Exit Signs Wall: Evenlite Slimline SL Series, green illuminating letters, stenciled brush aluminum face plate with SELF-LUMINOUS TEXT. Finish: brushed aluminum, 8-1/4"H x 12-3/4"L x 3/4" thick, single face, one type of sign at each exit door.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Beginning of installation means installer accepts existing surfaces.

3.02 INSTALLATION

- A. Install signs only after surfaces are finished at exit locations.
- B. Installation:
 - 1. Concealed mounting: Install with manufacturer's attachment.
 - 2. Plastic signs: Install with clear silicone adhesive meeting ASTM C834, with zero clearance between plastic and face of substrate. At mechanical fastening, pre-drill holes to prevent breaking plastic, use countersunk drill bits to flush screw head with sign surface.
- C. Low and High level mountings as indicated on Drawings and comply with requirements of Section 1011.8 CBC.
 - 1. Low level signs: Install not less than 6 inches or more than 8 inches above finish floor to the bottom of sign. Install the closest edge of sign within 4 inches of door frame.
- D. Clean and polish.

SECTION 10 44 13

FIRE EXTINGUISHERS AND CABINETS

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Fire extinguishers.
 - B. Cabinets.

1.02 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. NFPA 10 2012 Standard for Portable Fire Extinguishers.
- C. CFC California Fire Code 2016, Chapter 9, Section 906 Portable Fire Extinguishers.
- D. Title 19, CCR, California Code of Regulations, Public Safety, State Fire Marshal Regulations, Division 1, Chapter 3.
- E. UL Underwriters Laboratories Inc., Fire Protection Equipment.
- F. ADA Americans with Disabilities Act of 1990
 - 1. ADA Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design.
- 1.03 SUBMITTALS
 - A. Product data showing physical dimensions, operational features, color and finish, anchorage details, rough-in measurements, location and details.
 - B. Manufacturer's installation instructions.
 - C. Manufacturer's operation and maintenance data. Include test, refill or recharge schedules, procedures and re-certification including requirements applicable to Work.
- 1.04 QUALITY ASSURANCE
 - A. Conform to Title 19-CCR, Division 01, Chapters 1 and 3, and 2016 CFC, Section 906 requirements for extinguishers.
 - B. Fire extinguishers shall have current certification tag attached.
 - C. Fire extinguishers must be UL certified.
 - D. Cabinets shall comply with CBC Chapter 11B, Sections: 11B-307, 11B-308, 11B-309 and 11B-403.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Do not install extinguishers when ambient temperatures may cause freezing.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products of following manufacturers form basis for design and quality intended.
 - 1. Larsen's Manufacturer's Company, Ft. Lauderdale, FL.
 - 2. Potter-Roemer, Inc., Santa Ana, CA., UL No. EX 3697.
 - 3. Amerex Corporation, Los Angeles, CA, UL No. EX 2835.
 - 4. Ansul Inc., Marinette, WI., UL No. EX 21993
 - 5. Kidde Mebane, NC., UL No. EX 966.
 - 6. JL Industries Inc., Bloomington, MN.
- B. Or equal as approved in accordance with Division 01, General Requirements for substitutions.
- 2.02 EXTINGUISHERS
 - A. ABC Multi-Purpose Dry Chemical:
 - 1. Red glossy polyester coated steel cylinder with pressure gauge and nozzle.
 - 2. Size: 5 lbs.
 - 3. Class: 2A:10B Positioning: 48 inches max. to handle.
 - 4. Provide and install hanger bracket accessory at exposed wall-mounted fire extinguisher units. Larsen's Model # 821/862, Potter-Roemer Model # 3903, securing model, or equal.
- 2.03 CABINETS
 - A. Model: Larsen's Model: 2409-6R (2-1/2" trim), provide Fire-Rated cabinets at rated assemblies (Larsen's Fire Shield "FS").
 - 1. Size: To accommodate extinguisher specified herein.
 - 2. Mounting Style: Semi-Recessed, bottom of cabinet at 32 inches above finished floor, 4 inches maximum projection.
 - a. Steel: Cold-rolled steel with electrostatically applied thermally-fused coating (for fire-rated assemblies), color as selected by the Architect from manufacturer's standard list.
 - 3. Door Style(s):
 - a. Duo Vertical Panel with lock.
 - 4. Glazing:
 - a. Clear Tempered safety glass.
 - 5. Lettering
 - B. Accessibility Type Latching and locking hardware be operable with a single effort by lever type hardware, or other hardware designed so as to not require grasping the opening hardware and not require a force greater than 5 lbs to open.
 - 1. Force required to activate controls shall not exceed 5 lbs.

- 2. Be recessed or semi-recessed in order not to protrude more than 4 inches from face of wall.
- 3. Mount so handle of fire extinguisher is 48" maximum AFF.
- 2.04 FABRICATION OF CABINETS
 - A. Form body of cabinet with tight inside corners and seams.
 - B. Pre-drill holes for anchorage.
 - C. Form perimeter trim and door stiles by welding, filling and grinding smooth.
 - D. Hinge doors for 180 degree opening with continuous piano hinge.
 - E. Glaze doors with resilient channel gasket glazing.
 - F. Pull Handle: U-pull type with roller catch, 5 pounds maximum operating force.

PART 3 - EXECUTION

- 3.01 INSPECTION
 - A. Verify rough openings for cabinet and mounting brackets are correctly sized and located.
 - B. Beginning of installation means acceptance of existing conditions.
- 3.02 INSTALLATION
 - A. Install cabinets plumb and level in wall openings. Locate cabinets to a height to yield a maximum of 48 inches from finish floor to top of handle of fire extinguisher unit.
 - B. Secure rigidly in place.
- 3.03 INSPECTION BY REGULATORY AGENCIES
 - A. Schedule inspection with agencies and Owner.
 - B. Furnish approval certificates issued by jurisdictional authorities.
- 3.04 SCHEDULE: FIRE EXTINGUISHERS AND CABINETS
 - A. As indicated in drawings: Class 2A:10B:C fire extinguisher and cabinet.

SECTION 11 41 21

WALK-IN COOLERS AND FREEZERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Walk-in site assembled, refrigerators. Refer to architectural drawings for dimensions and arrangement of units. This equipment is Owner Furnished/Contractor Installed.
- B. Refer to the architectural drawings for refrigeration equipment schedules and installation details.
- C. Refer to Section 23 23 00, REFRIGERANT PIPING, for piping and insulation.
- D. Refer to electrical drawings for lighting.
- 1.02 RELATED WORK
 - A. Section 23 23 00, REFRIGERANT PIPING.
- 1.03 QUALITY ASSURANCE
 - A. Sanitary Standard: Walk-in units in food service shall comply with NSF Standard No. 7 and bear the NSF label.
 - B. Safety Standard: ASHRAE 15 describes requirements for refrigerant containing parts.
 - C. Cooler/Freezer installation shall comply with DSA IR A-14.
- 1.04 SUBMITTALS
 - A. Submit in accordance with Section 01 30 00.
 - B. Manufacturer's Literature and Data:
 - 1. Walk-in units, including assembly instructions.
 - 2. Condensing units, with mounting rack where required.
 - 3. Unit coolers.
 - 4. Temperature controls and alarms.
 - 5. Diagrams and details of piping, wiring and controls.
 - C. Operating Test Data.
 - D. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- 1.05 APPLICABLE PUBLICATIONS
 - A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- B. Air-Conditioning and Refrigeration Institute (ARI):
 - 1. 420-00 Unit Coolers for Refrigeration.
 - 2. 520-04 Performance Rating of Positive Displacement Condensing Units.
- C. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
 15-10 Safety Standard for Refrigeration Systems
- D. American Society for Testing and Materials (ASTM):
 - 1. A167-99 Stainless and Heat-Resisting Chromium-Nickel Steel plate, Sheet and Strip
 - 2. E84-11 Surface Burning Characteristics of Building Materials
- E. National Sanitation Foundation (NSF):
 - 1. 7-09 Commercial Refrigerators and Storage Freezers.

PART 2 - PRODUCTS

- 2.01 MANUFACTURERS
 - A. Commercial Cooling, City of Industry, CA.
 - B. Or approved equal in accordance with Division 1, General Requirements for Substitutions.
- 2.02 WALK-IN REFRIGERATOR/FREEZER CONSTRUCTION
 - A. Panels shall be NSF listed, meet 2009 E.I.S.A. requirements and certified with the DOE.
 - B. Panel Construction:
 - 1. Panels shall be construction with interior and exterior metal skins precisely formed to ensure proper size.
 - 2. Panel core shall be UL listed, Class 1 fire rated, polyurethane foam, using non-CFC propellant.
 - 3. Standard panel sections shall be interchangable nominal 48" widths. Special panels sized to meet custom requirements.
 - 4. Corners and T panels shall be constructed with minimum 1/4" radius in accordance with NSF standard #7.
 - C. Insulation:
 - 1. CFC-Free Class 1 fire rated polyurethane foam core. UL-723 < = 25 flame spread and smoke developed < = 450, in accordance with ASTM E84.
 - 2. Urethane, as specified, shall be foamed in place and cured to a solid rigid state between metal panel skins at an average density of two pounds per cubit foot.
 - 3. K factor not to exceed .125 at a 20 degree F mean. K factor not to exceed .140 at a 55 degree F mean.
 - 4. Insulation shall have 97% closed cell structure and conform to international standards for ozone depletion contribution.
 - D. Section Fasteners and Connectors:

- 1. Each device shall consist of a precisely located cam lock and steel pin.
- 2. All locks shall be actuated from inside the enclosure with a standard hex type Allen wrench.
- 3. All access holes are to be finished with white snap in cover caps on wall and ceiling panels and stainless steel caps on floor panels.
- E. Section Gasket:
 - 1. All panel sections shall have two rows of closed cell gasket adhered to the top, bottom, and cam lock side of the panel, creating a self-sealing, air tight joint.
 - 2. Gasket shall be NSF approved vinyl extruded gasket.
- F. Swing Doors:
 - 1. Cooler doors to be 36" x 78", flush construction with extruded steel reinforced PVC frame and jamb assembly with magnetic gaskets.
 - 2. Freezer door to include frame and threshold heaters.
 - 3. Door finish to match panel finishes inside and out.
 - 4. Insulation for door leaf to be 4" thick, same as panel specification.
- G. Finish:
 - 1. The interior and exterior panels shall be stucc galvalume steel with factory baked-on white enamel finish. Unexposed exterior surfaces can be stucco galvalume steel.
- H. Closures and Trim:
 - 1. Include matching trim strips and ceiling closure panels between walk in walls and building walls as necessary.
- I. Accessories:
 - 1. Kason 1806 LED light fixture.
 - 2. Kason 1967-3 temperature display
 - 3. Kason 1825 heated vent.
- J. Refrigeration:
 - 1. Refrigeration equipment to be sized per ASHRAE holding only standards.
 - 2. This equipment is OFCI, see plans for schedules.
 - 3. Coolers to include air defrost timer.

2.03 ROOM TEMPERATURE AND HUMIDITY CONTROL ALARMS

- A. Provide a local audible and visual over-temperature alarm with silencer switch, for each refrigerator/freezer. Provide contacts for a remote alarm at Engineering Control Center. Locate devices in a stainless steel enclosure by the door. Where shown on the drawings provide an additional remote alarm located in an adjacent corridor.
- B. Thermostat: Same as for temperature control, with bulb located near the ceiling of the room.
- C. Humidity Control: as recommended by manufacturer.

2.04 PIPING, PIPE INSULATION, AND REFRIGERANT AND OIL CHARGES

A. Refer to Section 23 23 00, REFRIGERANT PIPING.

2.05 EQUIPMENT IDENTIFICATION REQUIREMENTS

A. Identify all walk-ins, refrigeration equipment and alarm devices.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Assemble walk-in units and install refrigeration equipment as described in the respective manufacturer's instructions. Make panel joints tight and seal all panel penetrations to prevent condensation or frosting.
 - 1. Unit cooler: NSF approval requires that the unit be suspended at 90 mm (3-1/2 inches) minimum distance below the ceiling to allow cleaning the top of the unit cooler.
 - 2. To the extent feasible, mount pipe, conduit, and instrumentation on the exterior and pass thru neatly drilled penetrations to the lights or other devices.
- B. Piping, Pipe Insulation and Refrigerant: Provide in accordance with Section 23 23 00, REFRIGERANT PIPING.
- 3.02 REFRIGERATOR/FREEZER START-UP, AND PERFORMANCE TESTS AND INSTRUCTIONS
 - A. Start-up Temperature Reduction: On start-up, reset the room thermostats daily for a maximum temperature drop of 8 degrees, on C scale (15 degrees on F scale per day down to 2 degrees C (36 degrees F), and a maximum of 6 degrees on C scale, (10 degrees on F scale) per day between 2 degrees C (36 degrees F) and final operating temperature. Coordinate start-up with Palomar HVAC staff.
 - B. Perform test in accordance with Division 01, GENERAL REQUIREMENTS. Operate each system and record conditions hourly for eight hours. Submit the following information:
 - 1. Station, Building and System Identification, Contractor, Date and Time.
 - 2. Compressor nameplate data: Make, model, horsepower, RPM, refrigerant and charge in pounds.
 - 3. Compressor operation: Approximate percentage running time, pressure gage readings, actual amps (starting and running), condenser water temperature in and out, or condenser entering air temperature.
 - 4. Room temperatures.
 - 5. Defrost and drain functions of unit coolers. Demonstrate alarm functions.
 - C. By arrangement with the Resident Engineer, 24 hours in advance, use the start-up and test period for required operation and maintenance instructions to personnel in accordance with Division 01, GENERAL REQUIREMENTS.



SECTION 11 53 14

LABORATORY WORK SURFACES

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Fabricated countertops of epoxy-resin with integral sink.
 - B. Anchorage and support components and accessories.
 - C. Related Sections:
 - 1. Section 06 41 16 Casework.
 - 2. Section 09 06 00 Schedules for Finishes.

1.02 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. California Building Code 2016.
- C. ASTM D790 Flexture Strength.
- D. ASTM D695 Compressive Strength.
- E. ADA Americans with Disabilities Act of 1990 as amended.
 1. ADA/Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design.
- 1.03 QUALITY ASSURANCE
 - A. Manufacturer: Company specializing in the manufacturer of epoxy-resin laboratory work surfaces with minimum 5 years experience.
- 1.04 REGULATORY REQUIREMENTS
 - A. Chapter 11B and California Building Code, 2016.
 - B. Laboratory Rooms/Work Rooms:
 - 1. Provide a minimum of 5% (1 in 20), but in no case less than one workstation designed and constructed to be accessible to persons with disabilities (persons seated in wheelchairs). Or provide a workstation that is so constructed as to be easily convertible to such a use without the use of tools, special knowledge or effort.
 - C. Laboratory Rooms: Minimum one station and at least 5% of al workstations shall be accessible.

- D. Teaching Facility Cubicles, Study Carrels: Provide a minimum of 5%, but at least one cubicle or carrel in each group (IE language, dental, audiovisual, typing, drafting, darkrooms).
- E. Knee Clearance: If seating for people in wheelchairs is provided at fixed tables or counters, knee spaces at least 27 inches high, 30 inches wide, and 19 inches deep shall be provided.
- F. Height of Work Surfaces: The tops of tables and counters shall be 28 inches to 34 inches from the floor or ground.
- 1.05 SUBMITTALS
 - A. Shop drawings showing materials, component profiles, fastening methods, assembly methods, joint details plumbing trim and schedule of finishes.
 - B. Product data.
 - C. Samples showing full color range.
- 1.06 DELIVERY, STORAGE AND HANDLING
 - A. Ship units to site in protecting crating or containers to preclude damage in shipping or storage.
 - B. Store materials to prevent warping, twisting or water damage.
- PART 2 PRODUCTS
- 2.01 MANUFACTURERS
 - A. Products of following manufacturers form basis for design and quality intended.
 - 1. Epoxyn Products, Mountain Home, AR.
 - 2. Thermo Fisher (Fisher Hamilton), Two Rivers, Wisconsin.
 - 3. Durcon Incorporated, Taylor, TX.
 - 4. Insul-Serv Inc. (ISI), Scottsdale, AZ.
 - B. Or equal as approved in accordance with Division 1, General Requirements for substitutions.
- 2.02 COUNTERTOPS
 - A. General:
 - 1. Tops, Curbs, Splash Rim: Provide smooth, clean, exposed tops and edges, in uniform plane free of defects. Make exposed edges and corners uniformly rounded.
 - 2. Top Sizes: Provide tops in lengths equal to one (1) modular work bench unit or table. Sections shall be butt-joined end to end without fasteners, forming a hairline seam.



- 3. Top Thickness: Maintain 1" minimum thickness with tolerance not exceeding +/-1/32". Provide front and end overhang of 1" over base cabinets where exposed, formed with continuous drip groove on under surface 1/2" from edge for epoxy resin tops.
- 4. Splash: Provide 4" high integral backsplash at all work bench locations.
- B. Molded Epoxy Resin:
 - 1. Molded Epoxy Resin tops shall be molded from a modified epoxy resin. Tops and curbs shall be a uniform mixture throughout their full thickness. Tops shall be non-glaring color. Table tops shall be 1" thick, with drip grooves provided on the underside at all exposed edges. Further, all exposed edges except as indicated below, shall be beveled to a 1.8" radius at front top edge and at vertical corners. Integrally molded 4" high curbs at the backs and ends of standard 31" and 24" wide tops shall be 1" thick, and the juncture between top and curb shall be coved to a 3/4" radius. Curbs on special width tops and around special cut-outs shall be the same thickness as the tops, bonded to the surface of the top to form a square joint. Sink cut-outs shall be smooth and uniform without saw marks and the top edge shall have a uniform radius of approximately 1/8". The bottom edge of the sink opening shall be finished smooth with the edge broken to prevent sharpness. Corners of sink cut-outs shall be radiused not less than 3/4". Provide sink support carriages under sinks.

2.03 FABRICATION

- A. Shop assemble work surfaces for delivery to site in units easily handled and to permit passage through building openings.
- B. Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes and drains. Verify locations of cutouts from on-site dimensions. Seal contact surfaces of cut edges.
- C. Backsplash: Coved.
- D. Edge: 1/8 inch bevel epoxy resin.
- E. Coated surfaces not acceptable.
- F. Colors: Black.

PART 3 - EXECUTION

- 3.01 INSPECTION
 - A. Verify adequacy of backing and support framing.
- 3.02 INSTALLATION
 - A. Set and secure work surfaces to uniform and continuous support.
 - B. Fasteners, hardware and clips shall be concealed.

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3.03 ADJUSTING AND CLEANING

A. Clean surfaces, fittings and fixtures.

SECTION 21 13 13

WET PIPE SPRINKLER AND STANDPIPE SYSTEM

PART 1 - GENERAL

- 1.01 GENERAL AND SPECIAL CONDITIONS:
 - A. General and special conditions apply to the work in this section
 - B. The contractor shall furnish all equipment, materials, tools, labor, engineering, drawings, etc. necessary for a complete fire protection system, with said system being made ready for the operations in accordance with the requirements of the Authority Having Jurisdiction. The purpose of the permit drawings and specifications is to convey to the contractor the scope of work required, all of which the Contractor is responsible to furnish, install, adjust, and make operable. The omission of the Owner of any necessary system component as required by the Authority Having Jurisdiction, in the specifications shall not relieve the Contractor of the responsibility for providing such necessity, without additional cost to the owner. The Contractor shall visit the site before submitting his bid and shall examine all existing physical conditions that may be material to the performance of his work. No extra payment will be allowed to the contractor as a result of extra work made necessary by his failure to do so. Any case of error, omission, discrepancy or lack of clarity shall be promptly identified to the owner, Architect, Engineer for clarification prior to the bid due date.
 - C. The Contractor shall provide all devices and equipment required by these specifications. Under no circumstances will the Contractor delete any equipment or devices without the written directive of the Owner.
 - D. This Section specifies materials, methods, and equipment to be used for automatic sprinkler system or a combine standpipe system and related fire protection piping to 5 ft outside building.
 - E. Each wet pipe zone shall begin with:
 - 1. Zone control valve with tamper switch.
 - 2. Check Valve (Combined standpipes).
 - 3. Flow switch.
 - 4. Inspectors test and drain valve.
 - 5. Pressure gauges.
 - F. This Section specifies design criteria for fire protection system. Zone and main piping layouts of fire protection system have been established, as it relates to architecture, structure and mechanical/electrical systems. Fire Protection Contractor, based on these layouts, shall produce installation drawings which are also referred to as shop drawings in this Specification.

1.02 SYSTEM ABBREVIATIONS AND DEFINITIONS

A. AHJ – Authority Having Jurisdiction

- B. ANSI American National Standard Institute
- C. Approved Unless otherwise stated, materials, equipment or submittal approved by the Engineer.
- D. Architect HMC Architects
- E. ASTM American Society for Testing and Materials
- F. AWS American Welding Society
- G. AWWA American Water Works Association
- H. Concealed Where used in connection with installation of piping or conduit and accessories, shall mean, "Hidden from sight" as in shafts, furred spaces, in soffits or above suspended ceilings.
- I. Contractor The Company awarded the prime contract for this work and any of its subcontractors, vendors, suppliers, or fabricators.
- J. Engineer P2S Inc
- K. Exposed Where used in connection with installation of piping or conduit and accessories, shall mean, "visible" or "not concealed".
- L. FDC Fire Department Connection
- M. FM FM Global.
- N. FM Approved Materials or equipment approved by Factory Mutual and included on the most recent edition of the FM Approval Guide.
- O. Furnish Supply materials.
- P. GPM Gallons per minute.
- Q. Install Install materials, mount, and connection equipment assemblies.
- R. NFPA National Fire Protection Association
- S. PIV Post indicating valve.
- T. Provide Furnish, install and connect.
- U. PSI pounds per square inch.
- V. Remove Remove material and equipment and restore surface.
- W. UL Underwriters Laboratories, Inc.
- X. UL Listed Materials or equipment by Underwriters Laboratories and included in the most recent edition of the UL Fire Protection equipment Directory.

1.03 SCOPE OF WORK:

- A. Provide complete fire protection system as outlined in the project specifications, including all labor, materials, permit, shop drawings and hydraulic calculations needed to furnish and install a complete functional automatic sprinkler system in accordance with NFPA 13, and all of the following:
 - 1. Wet pipe automatic sprinkler system thought the building, complete with supervised control valves, inspectors test and main drains assemblies, vane type water flow switch, and pressure gauges.
 - 2. The sprinkler on each floor shall have a control valve, check valve, flow and tamper switch, and inspector test and drain assembly, located within fire riser closet.
 - 3. Any required core drilling of floors and walls, and provide FM approved noncombustible fire stopping materials at all fire protection piping penetrations of fire resistance rated construction. Piping penetrations shall be adequately fire stopped to maintain the fire resistance rating required.
 - 4. Earthquake bracing and flexible coupling.
 - 5. Furnish, install and adjust all waterflow and valve supervisory switches.
 - 6. Coordinate all work with other trades. During bidding, Contractor shall review his work with other trade to identify any obstructions from beams, ducts, diffusers, lights, structures, etc. Provide cost allowance for piping adjustment, additional piping and sprinklers as required. All changes shall be reflected on shop drawings.
 - 7. Coordinate and interface of alarm initiating and supervisory devices with the fire alarm system.
 - 8. Coordinate size of sewer connection with the drain riser with plumbing contractor to ensure adequate drainage of the drain riser during testing.
 - 9. Fire department connections.
 - 10. Shop drawings.
 - 11. Two (2) sets of operating instructions and valve diagrams.
 - 12. As-built drawings. The Contractor shall provide as-built drawings in Revit and PDF format in addition to required full size reproducible drawings.
 - 13. Contractor shall provide hydraulic calculation if there is any deviation or propose deviation from the approved set as a result of site condition and coordination.
 - 14. On-site project supervision.
 - 15. Required signs in English at all control valves, main drains, auxiliary drains and inspectors test connections, etc., including hydraulic placards, in accordance with NFPA 13 and NFPA 14 requirements.
 - 16. Cabinet containing the required number and type of spare sprinklers and corresponding wrenches, to be located in riser room.
 - 17. All required system testing in accordance with NFPA 13, 14, 22, 24, and 25.
 - 18. Warranty on all materials and labor.
 - 19. All permits, taxes and fees, including AHJ inspection and testing fees necessary to complete the specified work.

1.04 RELATED WORK:

- A. Materials and methods specified in other sections, included but not limited to:
 - 1. Cutting and patching.
 - 2. Fire extinguishers, cabinets, and accessories.

- 3. Painting of finished surfaces at pipe penetrations by other than Contractor.
- 4. Grading.
- B. Materials furnished and installed in this section but wired by others:
 - 1. Valve supervisory devices shall be furnished and installed the Contractor but wired by the alarm contractor.
 - 2. Water flow switches shall be furnished and installed by the Contractor but wired by the alarm contractor.

1.05 DESIGN CRITERIA

- A. Flow Test: See drawings.
- B. This flow test data will be used as basis for Contract Documents. Sprinkler Contractor, prior to preparation of installation design calculations, shall validate this flow data.
- C. Send current hydrant flow test data to Engineer.
- D. Hydraulically calculated system shall be designed to a minimum of 10% below available water flow curve.
- E. Systems that are hydraulically calculated must include 1.2 factor for design area.
- F. Sprinkler System:
 - 1. Office areas and general building spaces shall be hydraulically designed to provide minimum density of 0.10 gpm per sq ft over most hydraulically remote 1500 sq ft. Maximum spacing shall not exceed 225 sq ft per head.
 - 2. Other mechanical equipment areas and parking garage shall be hydraulically designed to provide minimum density of 0.15 gpm per sq ft for most remote 1500 sq ft. Maximum spacing shall not exceed 130 sq ft per head.
 - 3. General storage areas shall be hydraulically designed to provide minimum density of 0.20 gpm per sq ft over most hydraulically remote 1500 sq ft. Maximum spacing shall not exceed 130 sq ft per head.
- G. Hose Streams:
 - 1. Add 100 gpm in Light Hazard and 250 gpm in Ordinary Hazard Classification hose stream to sprinkler zone hydraulic calculations.
- H. Fire Protection System Layout and Shop Drawings:
 - 1. Contractor shall review Design Drawings and Specifications, and shall produce Shop Drawings, calculations, and product data sheets.
 - 2. Conceal sprinkler piping above ceilings where possible.
 - 3. Contractor shall consult with Architect during development of piping layout to avoid conflicts with general appearance. Pipe routing is a critical issue due to attributes of this building.
 - 4. Submit shop drawings, calculations and product data sheets for coordination review to: Architect, and other Authorities Having Jurisdiction over this Project prior to installation (see submittals).
 - 5. Contractor shall be held to have examined "Reflected Ceiling" drawings as well as Mechanical, Electrical, Piping, Information Technology, Structural and Architectural building plans prior to system layout.

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- 6. Contractor shall coordinate routing of piping with other trades and Architect.
- 7. Contractor shall participate in coordination process and shall not install piping prior to coordination with other trades.

1.06 QUALITY ASSURANCE:

- A. Codes and Standards:
 - 1. NFPA 13, Installation of Sprinkler Systems
 - 2. NFPA 14, Installation of Standpipe and Hose Systems
 - 3. NFPA 72, National Fire Alarm Code
 - 4. Underwriters Laboratories (UL) Fire Protection Equipment Directory
 - 5. California Building Code Latest Version
 - 6. California Fire Code Latest Version
 - 7. Title 19 of California Code of Regulations
- B. Contractor Installation Program:
 - 1. Licensed persons employed by Sprinkler Contractor shall perform planning, calculations, layout, and installation. Certified sprinkler designer, National Institute for Certification of Engineering Technologies, (NICET) Level IV or licensed Professional Engineer for planning and calculations, and journeyman sprinkler fitters for installation foreman and supervisory personnel.
 - 2. Journeyman automatic fire sprinkler fitter(s) shall supervise field installation.
 - 3. Contractor shall be licensed in the State of California for Installation of Fire Protection Systems.
 - 4. Contractor shall submit pre-qualification evidence of at least 3 projects of comparable size successfully completed with their Bid.
 - 5. Distortion or misrepresentation of qualification evidence may result in Contract cessation.
- C. Electrical Coordination:
 - 1. All relays, wire, conduit, pushbuttons, pilot lights, and other devices required for power side or the control of electrical equipment shall be furnished by Division 26 and Division 28 contractors, except as specifically noted elsewhere in this specification.
 - 2. Should any change in electrical equipment size, horsepower rating or means of control be made to any motor or other electrical equipment after contracts are awarded, sprinkler contractor is to immediately notify Division 26 and Division 28 contractors of this change and pay any costs due to this change.
 - 3. Division 26 contractors shall provide all power wiring and sprinkler contractor shall provide all control wiring and its conduit. Control wiring shall conform to Division 26 and 28 requirements for control wiring.
 - 4. Sprinkler contractor shall provide exterior waterflow alarm and coordinate installation with Division 26 and Division 28 contractors.
 - 5. Furnish wiring diagrams to Division 26 and Division 28 contractors for all equipment and devices furnished by the sprinkler contractor which have been indicated to be wired by the Division 26 and Division 28 contractors.

1.07 APPROVALS

A. P2S Inc. has prepared permit drawings, which have been approved by DSA. The Contractor shall use these drawings to prepare shop drawings to be used in system installation. The contractor shall submit the shop drawings to the Engineer for approval prior in system installation.

1.08 SUBMITTALS:

- A. Contractor shall submit complete system packages. Partial submittals will be rejected.
- B. Shop Drawings
 - 1. Contractor shall review Design Drawings and Specifications and shall produce Shop Drawings, calculations and product data sheets.
 - 2. Conceal sprinkler piping above ceilings where possible.
 - 3. Contractor shall consult with Architect during development of piping layout to avoid conflicts with general appearance. Pipe routing is a critical issue due to attributes of this building.
 - 4. Submit three sets of complete shop drawings, and three sets of manufacturer's data to Architect, Engineer, for all necessary reviews prior to fabrication and installation of materials. Three sets of hydraulic calculations shall be provided if contractor propose any deviation to the approved set.
 - 5. Hydraulic calculations shall include a water supply graph and hydraulic cover sheet. The cover sheet shall include the name and location of the calculated area, ceiling height, occupancy, design criteria, sprinkler spacing, system type, sprinkler make, model, size, K-factor and temperature rating, flow requirements, C-factor used, water supply data and source of information.
 - 6. Contractor shall be held to have examined "Reflected Ceiling" drawings as well as Mmechanical, Electrical, Piping, Information Technology, Structural and Architectural building plans prior to system layout.
 - 7. Contractor shall coordinate routing of piping with other trades and Architect.
 - 8. Contractor shall participate in coordination process and shall not install piping prior to coordination with other trades.
 - 9. Prepare shop drawings with a minimum scale of 1/8 inch = 1 foot-0 inch for plans, and 1/4 inch = 1 foot-0 inch for details. Show all piping, sprinklers, hangers, type of pipe, tube connections, outlets, type of roof construction, and occupancy of each area, including ceiling and roof heights as required by NFPA 13. When welding is planned, shop drawings shall indicate the sections to be shop welded and the type of welded fittings to be used. All drawings shall be prepared using Revit.
 - 10. Design shall be based on these specifications and the appropriate NFPA standards.
 - 11. Shop drawings shall include details of earthquake sway bracing, including the appropriate calculations.
 - 12. Shop drawings shall include details of underground thrust blocking/restraints.
- C. Changes

- 1. Make no changes in installation from layout as shown on the DSA Approved Dwgs. unless change is specifically approved by the Engineer and DSA. This does not include minor revisions for the purpose of coordination.
- 2. Any pipe fabricated and/or installed before all approvals are obtained at the Contractor's own expense and responsibility. Any changes made to the approved drawings other than as stated above are at the Contractor's own expense and responsibility.
- D. Manufacturer's Data
 - 1. Provide data from manufacturer on the following devices, including installation, maintenance, and testing procedures, dimensions, wiring diagrams, etc. Where any devices that are provided or furnished involve work by someone other than the Contractor, submit additional data copies directly to the Contractor. At a minimum, the following data sheets shall be provided:
 - a. Sprinklers and escutcheons.
 - b. Pipe, fittings and hangers.
 - c. Control valves.
 - d. Tamper switches.
 - e. Flow switches.
 - f. Exterior Weatherproof Waterflow Alarm.
 - g. Sprinkler Heads.
 - h. Sprinkler Head Cabinet.
 - i. Hanger Assemblies
 - j. Pressure Gauges.
 - k. Drawings.
 - I. Seismic Restraint Detailing.
 - m. Fire Department Connection (FDC)
 - n. Fire Department Valves (FDV).
 - o. Check valves.
 - p. Waterflow devices.
 - q. Valve supervisory devices.
 - r. Fire hose valve.
 - s. Bell.
 - t. Fire stopping materials (including installation detail).
 - 2. Include items listed in product section and additional items required to provide complete installation.
 - 3. Indicate by red marking or arrow, items to be used where more than 1 item appears on manufacturer's catalog sheet.
 - 4. Submit shop drawings and equipment submittals to Engineer and Owner's Insurance representative prior to installation or fabrication of system components.
 - 5. Review of submittals does not relieve Contractor from coordinating installation of work with other trades, or from compliance with Codes and Standards.
- E. As-Built Drawings
 - 1. Maintain at the site an up-to-date marked set of as-built drawings, which shall be corrected and delivered to the Owner upon completion of work.
 - 2. Upon completion, furnish the Owner with 3 sets of reproducible sepia prints, and one set in electronic Revit and PDF format of each reviewed shop drawing, revised to show "as-built" conditions.

- F. Samples
 - 1. Provide one sample of each type of sprinkler and escutcheon.
- G. Final Inspection and Test
 - 1. The Contractor shall make arrangements with the Owner, Owner's commissioning agent, Architect, Engineer for final inspection and witnessing of the final acceptance tests. The Owner, Architect, and the Engineer will witness the final inspection.
 - 2. Perform all tests and inspections required by the referenced codes and standards, the AHJ, and the Owner.
 - 3. When the Engineer visits the job site for final inspection and tests after being advised by the Contractor that the work is complete and ready for test, if the work has not been completed or the final acceptance tests are unsatisfactory, the Contractor shall be responsible for the Engineer's extra time and expenses for reinspection and witnessing the retesting of the work. Such extra fees shall be deducted from payments by the Owner to the Contractor.
 - 4. Upon completion of final inspections and tests, as required by appropriate NFPA Standards, submit copies of Standard Contractor's Material and Test Certificate.
- H. Operating Instruction
 - 1. At the completion of the work, provide a small scale plan of building indicating the locations of all control valves, low point drains, and inspector's test valves. The plans shall be neatly drawn and color-coded to indicate the portion of the building protected by each system, framed under glass and permanently mounted on the wall at the pump room.
 - 2. Furnish one copy of NFPA 25, CA Amended 2013 Edition and bound set of printed operating and maintenance instructions to the Owner, and adequately instruct the Owner's maintenance personnel in proper operation and test procedures of all fire protection components provided, furnished, or installed.

1.09 SPARE PARTS

- A. Provide and install one spare sprinkler cabinet, complete with 12 sprinklers of all types and temperature ratings used throughout the installation. The cabinet shall be equipped with sprinklers and special sprinkler wrenches required for each type of sprinkler installed.
- B. Confer with the Owner's representative for exact location of cabinet.

1.10 GUARANTEE

A. The Contractor shall guarantee all materials and workmanship for a period of one year beginning with the date of final acceptance by the Owner. The Contractor shall be responsible during the design, installation, testing and guarantee periods for any damage caused by his (or his subcontractors') work, materials, or equipment.

1.11 PRODUCT DELIVERY

A. Delivery of Materials: Delivery of all materials and equipment to the job site shall be scheduled to assure compliance with the predetermined construction schedules.

- B. Storage of Materials, Equipment and Fixtures: Contractor shall be responsible for storage of materials on job site, including furnishing of any storage facilities or structures required.
- C. Handling Materials and Equipment: Contractor shall be responsible for on-site handling of materials and equipment.

1.12 QUALITY ASSURANCE

- A. Testing Agency: All materials shall be UL listed or FM approved for their intended use.
- B. Regulatory Agencies: State and local building codes and ordinances, and fire department requirements shall apply.
- C. The Contractor shall be fully experienced and licensed in all aspects of the fire protections systems herein specified.
- D. Similar materials shall be from a single manufacturer.

1.13 JOB CONDITIONS

- A. Damage: Protect all unfinished work to prevent damage and furnish protection of all surrounding areas where necessary.
- B. Leak Damage: The Contractor shall be responsible during the installation and testing periods of the sprinkler system for any damage to the work of others, to the building or its contents caused by leaks in any equipment, by unplugged or disconnected pipes or fittings, or by overflow, and shall pay for the necessary replacements or repairs to work of others damaged by such leakage.

1.14 EMERGENCY SERVICE

A. The Contractor shall provide emergency repair service for the sprinkler system within four hours of a request for such service by the Owner during the warranty period. This service shall be available on a 24-hour per day, seven-day per week basis.

1.15 TRAINING

- A. The Contractor shall conduct two training sessions of four hours each to familiarize the facility personnel with the features, operation and maintenance of the sprinkler systems. Training sessions shall be scheduled by the Owner at a mutually agreeable time to the Contractor and the Owner.
- 1.1 PERMITS AND FEES
 - A. Pay for all permits, fees and charges required for this work.

PART 2 - PRODUCTS
2.01 GENERAL

- A. All components shall be used in accordance with the manufacturer's recommendations and its UL listing and/or FM approval.
- B. The naming of manufacturers in the specifications shall not be construed as eliminating the materials, products or services of other manufacturers and suppliers providing approved equivalent items.
- C. The substitutions of materials or products other than those named in the specifications are subject to proper approval of the Owner granted in writing.

2.02 MATERIALS

- A. Materials and Equipment
 - 1. Materials and equipment in system shall be new and current products of manufacturer regularly engaged in production of such materials and equipment.
 - 2. Where 2 or more pieces of equipment are required to perform interrelated functions, they shall be products of 1 manufacturer.
 - 3. Clean and cap pipe after fabrication and prior to placing pipe in building.
 - 4. Mark pipe with tags that can be removed during installation so no permanent markings remain on unpainted pipe located in exposed areas.
 - 5. Couplings shall be tees with capped outlets.
- B. Approval Guides:
 - 1. Unless otherwise shown, products shall be UL Listed in the latest publication of the UL Fire Protection Equipment Directory or Approved in the latest Factory Mutual Approval Guide for service intended.
- 2.03 PIPE
 - A. Above Ground:
 - 1. Standpipe Piping
 - a. Carbon steel pipe, Schedule 10, ASTM A795, ASTM A53 or A135, roll grooved for mechanical fittings.
 - b. Carbon steel pipe, Schedule 40, ASTM A795, ASTM A53 or A135, cutgrooved for mechanical fittings.
 - c. Provide metal pipe's exposed threads with corrosion inhibitive paint.
 - d. Pipe shall be new, Schedule 10, 6-inch minimum, rated for 300 psi, conforming to ASTM specifications, and have the manufacturer's name and brand along with the applicable ASTM standard marked on each length of pipe.
 - 1) Pipe used shall be black steel and must comply with the specifications of the American Society for Testing and Materials, ASTM A 53 welded and seamless steel pipe.
 - 2. Feed Mains and Branch Piping
 - a. Carbon steel pipe, Schedule 10, ASTM A795, ASTM A53 or A135, rollgrooved for mechanical fittings.
 - b. Carbon steel pipe, Schedule 40, ASTM A795, ASTM A53 or A135, cutgrooved for mechanical fittings.

- c. In areas such as tight ceiling spaces or where exact center-of-tile placement is critical, only FlexHead sprinkler pipe is permitted. Models 2024, 2036, 2048, 2060, 2072 as manufactured by FlexHead Industries, Acton Massachusetts. Each FlexHead ceiling sprinkler system shall include multi-port ceiling mounting bracket and a 1-piece tested FlexHead sprinkler drop including adjustable flange and hardware. No other flexible sprinkler pipe is allowed for this project unless it is both UL Listed and FM Global Approved. Alternates to FlexHead flexible sprinkler pipe must also be acceptable to Owner.
- d. Provide metal pipe's exposed threads with corrosion inhibitive paint.
- e. Pipe shall be new, rated for 175 psi working pressure, conforming to ASTM specifications, and have the manufacturer's name and brand along with the applicable ASTM standard marked on each length of pipe.
 - 1) Pipe used shall be black steel and must comply with the specifications of the American Society for Testing and Materials, ASTM A53 for welded and seamless steel pipe.
 - 2) Schedule 40 piping is required for sizes 2 inches and less. Pipe ends shall be threaded or roll grooved in accordance with NFPA 13.
 - Schedule 10 piping shall be provided for sizes 2¹/₂ inches and larger. Pipe ends shall be welded or roll grooved in accordance with NFPA 13.
 - 4) Hot-dipped galvanized pipe shall be used when exposed to the outside.
 - 5) Hot-dipped galvanized pipe shall be used for drain pipe.

2.04 FITTINGS AND JOINTS

- A. Above Ground:
 - 1. Cast iron threaded, Class 125, 175 psi WOG pressure rating, ANSI B16.4.
 - 2. Cast iron flanged, Class 125, 175 psi WOG pressure rating, ANSI B16.1.
 - 3. Grooved:
 - a. Ductile iron or malleable iron, grooved for mechanical coupling, 175 psi WOG pressure rating, malleable iron conforming to ASTM A536 for ductile iron and ASTM A47 for malleable iron.
 - b. Fitting, gasket and coupling shall be furnished by same manufacturer.
 - c. Acceptable manufacturers: Victaulic, Gruvlok or Viking Corp.
 - d. Grooved fittings and couplings shall be produced by the same manufacturer.
 - e. Grooved couplings shall be dimensionally compatible with pipe.
 - 4. Screwed fittings shall be cast iron, 175 pound class, black, and in accordance with ANSI B 16.4 or malleable iron, 175 pound class, black and in accordance with ANSI B 16.3. Bushings shall not be used.
 - 5. Fitting, gasket and coupling shall be furnished by same manufacturer.
 - 6. Galvanized, cast iron, threaded fittings, 175 psi WOG pressure rating, ANSI B16.4.
 - 7. Fittings shall be hot-dipped galvanized when installed on galvanized piping.

- 8. Weld-o-lets welded to piping in fabrication shops are permitted. No welding allowed at project site.
- 9. Weld fittings shall be steel, standard weights, black, and in accordance with ASME B 16.9, ASME B 16.25, ASME B 16.5, ASME B 16.11 and ASTM A 234.
- 10. Pipe-o-lets or similar clamp on or saddle type fittings are not allowed as fittings.
- 11. Saddle type devices that strap or clamp onto piping are not allowed.

2.05 FIRE HOSE VALVES

A. Hose threads shall match those used by AHJ. Each hose valve shall be provided with an approved pressure-reducing device designed to limit nozzle pressure to 100 psi at 2½-inch valves.

2.06 VALVES:

- A. Gate Valve:
 - 1. Acceptable manufacturers: Kennedy, Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic.
 - 2. Outside screw and yoke (OS&Y), gate valve, bronze body and trim or cast iron body bronze mounted and rated for 175 psi, non-shock cold water working pressure, Nibco F-607-OTS or equal.
- B. Check Valve:
 - 1. Acceptable manufactures: Tyco Fire Products, Reliable, Viking Corp.
 - 2. Iron body, bronze seat, stainless steel clapper with a replaceable rubber seal and 175 psi nonshock cold water working pressure. Viking Model G-1 or equal.
- C. Ball Valve:
 - 1. Acceptable manufacturers: Nibco, Milwaukee Valve Co., Mueller, Victaulic.
- D. Butterfly Valve:
 - 1. Acceptable manufacturers: Victaulic, Kennedy, Milwaukee Valve Co.
 - 2. Victaulic Series 705 Firelock or equal for valve sizes 2-1 /2" to 8".
 - 3. Milwaukee Valve Co., Series BB or equal.
 - 4. Kennedy Valve Co., Fig. 0IG.
- E. Test and Drain Valves:
 - 1. Acceptable manufacturers: AGF, Victaulic or equal.
 - 2. AGF Test and Drain Victaulic Style 720 TestMaster II or equal may be installed.
- F. Drain Valves:
 - 1. Acceptable manufacturers: Kennedy, Nibco or equal.
 - 2. Thread-in bonnet bronze globe valves, rated to 175 psi non-shock cold water working pressure.
 - 3. Low point drain valves shall have, 3/4" brass nipple with 3/4" male hose threads and cap.

2.07 FIRE DEPARTMENT CONNECTION

A. Fire department connection shall be pilaster mounted with four (4) 2¹/₂-inch inlets connected to a 6-inch pipe.

- B. Plate shall describe area of service.
- C. Finish for plate and connector shall be chrome.
- D. Exposed caps and fittings shall be chrome.
- 2.08 TAMPER SWITCH
 - A. Acceptable manufacturers: Potter, System Sensor or equal.
 - B. Outside screw and yoke (OS&Y) supervisory switch, NEMA 4 enclosure, provided with 2 sets of contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Equal to Potter OSYSU¬2. Provide with cover tamper kit. For areas identified as hazardous locations, provide "EX" Model.
 - C. Control valve supervisory switch, NEMA 4 enclosure, provided with 2 sets of contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Equal to Potter PCVS-2. Provide [with] [without] optional cover tamper kit. For areas identified as hazardous locations, provide "EX" Model.
 - D. Tamper switch shall be capable of transmitting signal during first 2 revolutions of handwheel or during 1/5 of travel distance of valve control apparatus from its normal position.
 - E. Unit shall be compatible with Fire Alarm System.
- 2.09 FLOW SWITCH
 - A. Acceptable manufacturers: Potter, System Sensor, or equal.
 - B. Vane type waterflow switch for use in wet sprinkler systems, 450 psi service pressure rating, 10 gpm minimal flow rate to activate alarm, 2 sets of SPDT (Form C) contacts rated at 2 Amps at 30 VDC and 15 Amps at 125/250 VAC. Provide with optional cover tamper kit. Equal to Potter VSR-F.
 - C. Unit shall be compatible with Fire Alarm System. Potter model VSR-F or equal.
- 2.10 FLEXIBLE HOSE
 - A. Flexible hose sprinkler system shall be rated for the following performance criteria:
 - 1. FM Approved for its intended use pursuant to FM 1637 Approval Standard for Sprinkler Hose with Threaded End Fittings.
 - 2. UL Listed for its intended use pursuant to UL 2443 Standard for flexible Sprinkler Hose with Fittings for Fire Protection Service.
 - Seismically qualified for use pursuant to ICC-ES AC-156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.
 - B. Materials: Flexible hose commercial sprinkler connections.
 - 1. Composition shall be 100% Type 304 Stainless Steel.

- 2. Straight Hose Assembly Lengths:
 - a. ³/₄ inch outlet
 - b. Maximum pressure rating: 175 psi.
 - c. Fully welded non-mechanical fittings, braided, leak-tested with minimum 1 inch true-bore internal corrugated hose diameter.
- 3. Elbow hose assembly lengths (for use in confined spaces).
 - a. 1/2 inch outlet
 - b. Maximum pressure rating: 175 psi
 - c. Fully welded non-mechanical fittings, braided, leak-tested with minimum 1 inch true-bore internal corrugated hose diameter.
- 4. Ceiling Bracket
 - a. Type G90 Galvanized Steel
 - b. Type: Direct attachment type, having integrated snap-on clips ends positively attached to the ceiling using tamper resistant screws.
 - c. Flexible hose attachment: Removable hub type with set screw.

2.11 SPRINKLER HEAD

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- A. Fire sprinklers installed on wet system shall be of one manufacturer throughout the building. No mixing of sprinkler brands shall be permitted.
- B. Manufacturers: Unless otherwise noted below, shall be manufactured by Viking Corp., Tyco Fire Products or Reliable.
- C. Automatic, having temperature rating suitable for location.
- D. Light Hazard and Ordinary Hazard occupancies shall be Quick Response type sprinkler heads.
- E. Architect will review deviations from the specified styles for approval prior to installation.
- F. Provide the following type of sprinkler head.
 - Unfinished areas such as areas with no ceiling, mechanical spaces, storage, etc.
 - a. Quick response, brass Upright, 1/2" orifice, ordinary temperature class (175°F),
 - b. Viking Model Microfast or equal.
 - c. Extended coverage, brass finish, Upright or Pendent, large orifice, ordinary temperature class (175°F), Viking ECOH-ELO or equal designed and installed per its listing.
 - 2. In areas with ceilings.

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- a. Concealed Pendent, 1/2" orifice, intermediate temperature class (175°F) solder link, Viking Mirage QR Concealed Pendent, Model B-2 adjustable sprinkler, with 165°F temperature rated cover plate, flush with ceiling or equal. Cover plate color shall match ceiling color and shall be factory-painted (i.e. by manufacturer).
- 3. In areas where ceiling conditions do not permit installation of pendent head or finished area where sidewall head provides better coverage of hazard.
 - Polished Chrome Sidewall, 1/2" orifice, ordinary temperature class (175°F),
 2- piece adjustable chrome escutcheon, Viking Model M, HSW horizontal or
 VSW vertical sidewall with Viking E-1 escutcheon or equal.
 - b. Extended Coverage Sidewall, ordinary temperature class (175°F), Tyco Fire Products, Model TY-FRB or equal designed and installed per its listing.
- 4. In unfinished areas where conditions do not permit installation of upright or pendent head.
 - a. Brass Sidewall, 1/2" orifice, ordinary temperature class (175°F), Viking Model M, HSW horizontal or VSW vertical sidewall or equal.
- 5. In parking garage areas.
 - a. Quick response, brass Upright or pendent, 1/2" orifice, intermediate temperature class (200°F),
 - b. Viking Model Microfast or equal.
 - c. Below duct sprinkler shall be pendent type. Sprinkler guard shall be provided where sprinkler heads are located below 7 feet from finished floor.
- G. Submit samples for examination and approvals.
- H. Temperature ratings of sprinkler heads shall vary if installed close to heat sources, under skylights or in special hazard areas.
- I. Sprinkler Cabinets:
 - 1. Complete with required number of spare sprinkler heads of each type and temperature
 - 2. rating and special wrenches per NFPA 13
 - 3. Provide multiple cabinets to meet this requirement.
 - 4. Coordinate cabinet locations with Owner's representative.

2.12 BALL DRIP

- A. Acceptable manufacturer: Potter-Roemer, Reliable, Tyco Fire Products or equal.
- B. Provide bronze ball drip for Fire Department connection inside of building and pipe to nearest floor drain, or discharge to exterior.
- C. Exterior discharge must be coordinated with Architect and Owner.
- 2.13 HANGERS
 - A. Provide hangers to support piping: in perfect alignment without sagging or interference, to permit free expansion and contraction, and meet requirements of NFPA 13.

- B. Riser clamps shall not protrude more than 2" beyond edge of hole. Provide Anvil Fig. 261 or equal.
- C. Concrete expansion anchors are to be Hilti, Rawl, or Phillips concrete fasteners.

2.14 EARTHQUAKE BRACING

- A. Sprinkler and standpipe system shall be protected from earthquake influence in accordance with requirements of NFPA 13.
- B. Provide flexible couplings, bracing, and other components required, compatible with piping material and jointing system used.
- C. Seismic detailing shall be included on Fire Protection System layout shop drawings.

2.15 PRESSURE GAUGES

- A. Acceptable manufacturers: Potter-Roemer, Viking or equal.
- B. Pressure gauges shall be 3-1/2", corrosion resistant moving parts, polycarbonate window, and provided with connection not smaller than 1/4" NPT.
- C. Include shutoff valve with provisions for draining on each pressure gauge.
- 2.16 DIELECTRIC FITTINGS
 - A. Acceptable manufacturers: Epco Sales, Inc., Lochinvar, Watts Regulator Co., Wilkins or equal.
 - B. Insulating nipple, metal casing, inert thermoplastic lining, Clearflow dielectric fitting by Perfection Corporation.
 - C. Dielectric unions 2" and smaller; dielectric flanges 2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets and pressure rating of not less than 175 psig at 180°F.
- 2.17 SLEEVES FOR WALL/FLOOR PENETRATIONS
 - A. Sleeves through walls and floors shall be of a type that can be made watertight and fire stopped.
 - 1. Sleeve sizes shall be as required by NFPA 13 and 14 for Earthquake Protection.
- 2.18 SIGNS
 - A. Provide standard metal signs in English in accordance with NFPA 13.
 - B. Provide hydraulic calculation information signs at risers in accordance with NFPA 13.

PART 3 - EXECUTION

3.01 GENERAL

- Product Deliverv Α.
 - Delivery of Materials: Delivery of all materials and equipment to the job site shall 1. be scheduled to assure compliance with the predetermined construction schedules.
 - 2. Storage of Materials, Equipment and Fixtures: Contractor shall be responsible for storage of materials on job site, including furnishing of any storage facilities or structures required.
 - Handling Materials and Equipment: Contractor shall be responsible for on-site 3. handling of materials and equipment.
- Β. Clean-up
 - 1 Maintain the premises free from accumulation of waste materials or rubbish caused by this work.
 - 2. At the completion of the work, removed all surplus materials, tools, etc., and leave the premises clean.
- C. Leak Protection
 - Damage: Protect all unfinished work to prevent damage and furnish protection of 1. all surrounding areas where necessary.
 - Leak Damage: The Contractor shall be responsible during the installation and 2. testing periods of the fire protection system for any damage to the work of others, to the building or its contents caused by leaks in any equipment, by unplugged or disconnected pipes or fittings, or by overflow, and shall pay for the necessary replacements or repairs to work of others damaged by such leakage.
- D. Safetv
 - All work shall be performed in compliance with the Occupational Safety and 1. Health Act of 1970 and the Construction Safety Act Standards.
 - Contractor shall attend all job safety meetings. 2.
- 3.02 FABRICATION
 - Α. Pipe Ends
 - Ream and remove burrs after cutting pipe. Standard wall pipe ends shall be 1. welded, threaded, cut grooved, or plain end.
 - 2. Thin wall pipe ends shall be plain end, welded or roll grooved in accordance with the fitting manufactures' recommendation.
 - Threads shall be in accordance with ASME B1.20.1. Each thread on light wall 3. pipe shall be gauged before the fitting is made-up.
 - Grooved Ends Β.
 - Pipe minimum thickness, squareness and out-of roundness shall be in 1. accordance with the coupling manufacturers specifications.
 - 2. Pipe surface shall be free of indentations, projections, or roll marks from the end of the pipe to the groove.
 - C. Welding
 - No field welding of sprinkler/standpipe piping shall be permitted. 1.
 - 2. Headers risers, feed mains, cross mains and branch lines may be shop welded using acceptable welding fittings. Welding methods shall comply with all the requirements of AWS B2.1.

- 3. Certified records shall be maintained upon the completion of each weld, welder shall stamp an imprint of their identification into the side of the pipe adjacent to the weld.
- 3.03 INSPECTION
 - A. Investigate site conditions; verify utility locations and elevations before start of excavation.
 - B. Discrepancies will be forwarded to Architect/Engineer before proceeding with construction
- 3.04 INSTALLATION
 - A. A clean set of prints or shop drawings shall be maintained at the site and marked up to show any changes.
 - B. Piping shall be installed above ceilings except in areas where there is no ceiling. Install piping in exposed areas as high as possible using necessary fittings and auxiliary drains to maintain maximum clear head room.
 - C. Install hydraulically designed sprinkler system and associated accessories according to requirements of NFPA 13 and as shown on drawings.
 - D. Install pipe and fittings according to recommendations of pipe manufacturer.
 - E. Keep materials within listed temperature range to assure jointing in accordance with manufacturer's requirements.
 - F. Pipe and fittings shall be of corresponding materials when assembled.
 - G. For underground pipe, in lieu of thrust blocks; anchors and tie rods can be provided. Tie rods shall be 3/4" diameter steel rod. Clamps shall be 3/8" thick by 2" wide steel. Each clamp shall be secured with four 5/8" diameter bolts.
 - H. Apply asphaltum or corrosion inhibitive paint to tie rods, clamps and bolts of underground pipe.
 - I. Provide readily removable fittings at end of cross-mains. Minimum size of flushing connection shall be 2".
 - J. Provide test connection for each flow switch.
 - K. Discharge test connections inside building to receptacles provided as part of plumbing system or to drain standpipe.
 - L. Drain line detailed adjacent to sprinkler risers shall be considered as part of Sprinkler System from combination test/auxiliary drain valve for each zone or sub-zone shown on plans to plumbing receptacle.

- M. Provide auxiliary drains at low points of systems. Where trapped section of pipe exceeds 5 gallons, drain shall consist of, as a minimum: valve, 3/4" brass nipple with 3/4" male hose threads, and cap.
- N. Identify valve with brass tag denoting which flow switch is being tested, when test valves are located remote from flow switch.
- O. Clamp-on or saddle type fittings are not allowed. Outlet fittings inserted into holes drilled into piping or pipe-o-lets are not allowed.
- P. Provide reducing fittings or provide shop fabricated weld-o-lets to change pipe sizes in sprinkler/standpipe systems. No bushings or grooved reducing couplings, such as Victaulic Style 750, are allowed.
- Q. Feed sprinkler heads, installed in finished ceilings, with swing joint or return bend arrangement for final positioning in ceiling grid pattern during construction phases. Sprinklers are required to be installed in the center of ceiling tiles.
- R. Provide minimum 1" outlets with sprigs or drops for sprinklers located in shelled spaces.
- S. Provide tamper switch on each shutoff valve.
- T. Provide locking device with each shutoff valve to prevent inadvertent closing of valve. Keys shall be indexed to identify valve location.
- U. Install sprinkler heads as recommended by manufacturer. Sprinklers shall be set level and at locations to avoid interference with spray pattern of sprinkler. When ducts and lights are obstructions to sprinkler distribution, provide additional heads beneath obstruction.
- V. Make joints of threaded pipe by cutting pipe square and reaming inside.
- W. Coat exposed threads with corrosion inhibitive paint. Use joint compound sparingly.
- X. Install joints for mechanical coupled pipe according to manufacturer's recommendations. Use manufacturer's gasket lubricant sparingly.
- Y. Pipe shall be cut grooved for Schedule 40 steel pipe or roll grooved for Schedule 10 steel pipe as specified by coupling manufacturer.
- Z. Welded joints shall be made in fabrication shop. No welding allowed at project site.
- AA. Hang pipe from building members using concrete inserts or beam clamps. Expansion type inserts may be used for branch piping.
- BB. Support piping in accordance with NFPA 13 Seismic Anchorage and Restraints, and in accordance with State and Local seismic restraint requirements.
- CC. Provide seismic restraint details and calculation with sprinkler shop drawings.

- DD. Provide pressure gauges as required in manufacturer's installation instructions, and as required per NFPA.
- EE. Generally install capped tees in lieu of couplings for future connections.

3.05 SPRINKLERS

- A. General
 - 1. Sprinklers below ceilings off of exposed piping shall be listed and approved regular bronze upright type, in upright position. Listed and approved regular bronze pendent type may be used where necessary due to clear height requirements, duct interference, etc.
 - 2. Pendent sprinklers shall be installed where suspended ceilings are located shall be concealed type and center of tile.
 - 3. Sprig-ups shall be provided wherever necessary to provide proper deflector distances in accordance with NFPA 13 requirements.
 - 4. Provide flex head for suspended T-bar ceiling to accommodate 1" minimum seismic movement.
 - 5. Provide sprinkler below duct with minimum width 4 ft and above.
- B. Sprinkler Guards and Water Shields
 - 1. Provide guards on sprinklers within 7 feet of finished floor or wherever sprinklers may be subject to mechanical damage.
- C. Drains
 - 1. Provide main drain valves at system control valves, sized in accordance with NFPA 13 and AHJ requirements that extend piping to exterior.
 - 2. Provide all auxiliary drains where necessary.
 - 3. Pipe all drains and auxiliary drains to locations where water drained will not damage stock, equipment, vehicles, planted areas, etc., or injure personnel.
 - 4. Plugs used for auxiliary drains shall be brass.
 - 5. All piping and fittings downstream of drain valve and gang drain shall be hotdipped galvanized.
 - 6. The Contractor shall comply with all water discharge restrictions.

3.06 VALVES

- A. General
 - 1. Valves shall be installed with sufficient clearance for operation, testing and maintenance.
 - 2. Where wafer bodied valves are used, they shall be installed so that the discs do not interfere with other components.
- B. Control valves shall be installed so that valve position indicator is visible.
- C. Drain, test, and trim valves.
 - 1. Valves shall be installed no more than 7 feet 0 inches above the finished floor and shall be accessible.
- D. Backflow Preventers

- 1. Install backflow preventers of reduced pressure detector assembly type with clearances required by AHJ and in compliance with manufacturer's recommendations for inspection, testing and maintenance.
- E. Floor Control Valves
 - Provide floor control valve assemblies within the stair enclosure on all floors. Each floor control valve assembly shall be equipped with a control valve, tamper switch, flow switch, inspector's test/drain trim assembly, pressure-relief valve not less than ½-inch in size and set to operate at 175 psi, and pressure-reducing device set at
 - 2. Pressure-reducing valves will require discharging to a gang drain.

3.07 FIRE DEPARTMENT CONNECTIONS

- A. Install with centerline of inlets neither less than 18 inches nor more than 48 inches above the finished grade or pavement.
- B. Piping from fire department connection to check valve shall be hot-dipped galvanized.
- 3.08 PRESSURE GAUGES
 - A. Gauges shall be located where not subject to freezing.
 - B. Gauges shall be provided vertically, with three-way valve with 1/4-inch plugged outlet, and as follows:
 - 1. Above and below wet system riser check valves.
 - 2. At each water supply and inlet of floor control valve.
 - 3. At inlet and outlet of each pressure-reducing floor control valve.
 - 4. At inlet of each pressure-reducing fire hose valve.
 - 5. At top of each standpipe.

3.09 HANGERS, SUPPORTS, AND EARTHQUAKE BRACING

- A. General
 - 1. All piping must be substantially supported from building structure and only approved types of hangers shall be used. Piping lines under ducts shall not be supported from duct work, but hall be supported from building structure with trapeze hangers where necessary or from steel angles supporting duct work in accordance with NFPA 13.
 - 2. All thread rods shall not be bent.
 - 3. Hanger components shall be ferrous.
 - 4. Powder driven studs shall be specifically listed for use in the required seismic zone.
- B. Feed and Cross Mains
 - 1. Install at least one hanger per length of pipe up to 8 feet in length joined by grooved couplings.
 - 2. Use flexible couplings where more than two couplings are used per run.
- C. Risers

- 1. Standpipes shall be supported at lowest level and alternate levels above using riser clamp.
- 2. Provide flexible couplings in standpipe.
- D. System Headers1. Install pipe saddle supports complete with flange bolted to floor.
- E. Earthquake Protection
 - 1. Install flexible joints and sway braces in accordance with NFPA 13, Section 9.3.

3.10 SLEEVINGS, WALL AND FLOOR PENETRATIONS

- A. Set Schedule 40 sleeves in place for all pipes passing through openings in fire resistance rated construction when required by UL listing for fire stopping method utilized.
- B. Provide clearance between the sprinkler piping and sleeves in accordance with NFPA and FM. The space between sleeve and pipe shall be filled with noncombustible, UL listed fire stopping materials. Provide chrome wall plates at each side of wall.
- C. Sleeves through floors shall be watertight. Penetrations through fire rated construction shall be adequately fire stopped to maintain the fire resistance rating required.

3.11 SIGNS

- A. Valves
 - 1. Secure to each valve with corrosion resistant wire or chain, sign stating, "Control valve."
- B. Hydraulic Design Information
 - 1. Secure to each system riser with corrosion resistant fasteners.

3.12 WATER FLOW ALARMS AND SUPERVISORY DEVICES

- A. Alarm Bells
 - 1. Electric bells and wiring diagrams shall be delivered to the alarm contractor for installation and wiring.
- B. Alarm and Supervisory Switches
 - 1. Deliver wiring diagrams to alarm contractor.
 - 2. Install alarm water flow switches in accordance with switch and valve manufacturers' instructions.
 - 3. Install and adjust valve supervisory switches in accordance with switch manufacturers' instructions.
- 3.13 INSPECTOR'S TEST
 - A. Provide inspector's test connections, as specified in NFPA 13, at required points for testing each waterflow alarm device. Special discharge nozzle shall have same size orifice as smallest orifice sprinklers installed.

- B. Provide 1-inch sight glass if inspector's test discharge cannot be readily observed while operating valve.
- C. Pipe all inspector's test connections discharging to atmosphere to location where water drained will not damage stock, equipment, vehicles, planted areas, etc., or injure personnel.
- D. Splash blocks shall be provided where inspector's test discharge could produce damage to surroundings.
- E. All pipe and fittings downstream of inspector's test valve shall be galvanized.
- 3.14 STANDPIPE IN BUILDINGS DURING CONSTRUCTION
 - A. Temporary or permanent standpipes shall be provided during construction (if required by the AHJ), extending up with each floor as construction progresses. Installation of standpipes in buildings under construction shall comply with the appropriate sections of CBC Section 905.10.
- 3.15 SYSTEM ACCEPTANCE
 - A. Tests
 - 1. General system test shall be coordinated with the Owner's representatives for training and witnessed by the AHJ and Owner's commissioning agent. Problems noted during testing such as air or water leaks, difficulty in operating valves, alarm failures, etc. shall be corrected before the Contractor leaves the job.
 - 2. Hydrostatically test all piping, including fire department connections between the check valve and connection, at 200 psi for two hours. If the highest static pressure at the lowest point in the system exceeds 150 psi, the system shall be tested at 50 psi more than the highest static pressure.
 - 3. Flow Tests
 - a. Main drain shall be opened wide until pressure stabilizes then slowly closed, noting and recording flowing (residual) and static (non-flow) pressure.
 - b. Pressure-reducing floor control valves and fire hose valves shall be tested noting inlet and outlet pressures under non-flowing and flowing conditions. Record results.
 - c. Pilot-operated pressure-reducing valves shall be tested as specified in (b). Adjust pilot for design pressures.
 - d. Backflow preventers shall be forward-flow tested.
 - 4. Pipe shall not be concealed until satisfactorily pressure tested.
 - 5. Conduct drain test. Record static pressure and residual pressure per NFPA 13.
 - 6. Owner's representative or engineer may witness tests. Contractor shall notify Owner and Engineer a minimum of 3 days in advance to allow for participation.
 - 7. Log of tests shall be kept at job site and shall identify:
 - a. Who performed test.
 - b. Time of test.
 - c. Date of test.
 - d. Section of system tested.
 - e. Results of test.

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- f. Along with completed Contractor's Material and Test Certification form(s) from NFPA 13 and NFPA 14.
- 8. Operate flow switches to test that signals are transmitted to Fire Alarm Control Panel.
- 9. Include test for tamper switches.
- B. Valve Operation
 - Operate each valve through its entire range. Adjust valve packing glands.
 a. Hose valves shall be capped during the test.
 - 2. Threads for hose valve/wall hydrant outlets and fire department inlets shall be verified to conform to those used by the AHJ.
- C. Water Flow and Supervisory Devices
 - 1. Coordinate testing of electric components with the alarm contractor.
 - 2. Each water flow device shall be tested in accordance with NFPA 72 by opening the inspectors test or alarm test valve.
 - 3. Each valve supervisory device shall be tested by operating the valve wheel/crank.
 - 4. Verify all signals have been noted by the fire alarm control panel and each audible alarm device operates.
- D. Contractor's material and test certificates shall be completed for each system/floor and signed by the Contractor and witnessed by the Owner's representative/AHJ.
- E. Training
 - 1. General In addition to the tests required in Parts A through C and witnessed by the Owner's representative(s), conduct one/two hour training sessions to familiarize the representatives with all operating features of the system, including control valve, drain and test valve locations and operations.
 - 2. Provide Owner's representatives with:
 - a. A small scale plan of the system/building showing locations of control, drain and test valves.
 - b. Component manufacturers' inspection and testing manuals.
 - c. Two copies of NFPA 25.
 - 3. Spare Parts
 - a. Provide 12 spare sprinklers of all types and ratings that are installed, in a steel cabinet complete with special sprinkler wrenches. Install cabinet as directed by Owner.

3.16 ADJUSTMENT AND CLEANING

- A. Cleaning: Flush all piping in accordance with NFPA Standards for test procedures.
- B. Ensure underground feed pipe has been flushed, to clear out construction debris, prior to connecting aboveground fire protection system to it.
- C. Maintain the premises free from accumulation of waste materials or rubbish caused by this work
- 3.17 BONDING

$H\!M\!C {\sf Architects}$

- A. Provide underground cast iron and underground ductile iron pipe with metallic bond at each joint.
- B. Bond wire shall be type RHW-USE size 1/0 neoprene-jacketed copper conductor shaped to stand clear of joint.

END OF SECTION

SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.

1.03 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 SLEEVES

- A. Galvanized-steel-sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- 2.02 SLEEVE-SEAL SYSTEMS
 - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Metraflex Company (The).
 - 2. Thunderline/Link Seal.
 - 3. Or approved equal.
 - 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.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Presealed Systems.
 - 2. Holdrite.
 - 3. Or approved equal.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.
- 2.04 GROUT
 - A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volumeadjusting, 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

- 3.01 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.
 - 1. Sleeves are not required for core-drilled holes.
 - C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. 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.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeveseal 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. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-ongrade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.
- 3.04 SLEEVE AND SLEEVE-SEAL SCHEDULE
 - A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized steel wall sleeve, sleeve seal system or sleeve seal fittings.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Galvanized steel wall sleeve, sleeve seal system or sleeve seal fittings.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

- 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Galvanized steel wall sleeve, sleeve seal system or sleeve seal fittings.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized steel wall sleeve or sleeve seal fittings.
- 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized steel sleeve.

END OF SECTION

SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS
 - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.
- 1.03 ACTION SUBMITTALS
 - A. Product Data: For each type of product indicated.
- PART 2 PRODUCTS
- 2.01 ESCUTCHEONS
 - A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
 - B. One-Piece, Stamped-Steel Type.
- PART 3 EXECUTION
- 3.01 INSTALLATION
 - A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
 - B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, cast-brass type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chromeplated finish.
 - c. Insulated Piping: One-piece, stamped-steel type.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.

- e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
- f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, castbrass type with polished, chrome-plated finish.
- g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.
- 3.02 FIELD QUALITY CONTROL
 - A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 22 05 19

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Liquid-in-glass thermometers.
 - 3. Thermowells.
 - 4. Dial-type pressure gages.
 - 5. Gage attachments.
 - 6. Test plugs.
 - 7. Test-plug kits.
- B. Related Sections:
 - 1. Section 22 11 16 "Domestic Water Piping" for water meters inside the building.
- 1.03 ACTION SUBMITTALS
 - A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ashcroft Inc.
 - 2. Trerice, H. O. Co.
 - 3. Weiss Instruments, Inc.
- B. Standard: ASME B40.200.
- C. Case: Liquid-filled type(s); stainless steel with 5-inch (127-mm) nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

- E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- F. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
- H. Window: Plain glass.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.
- 2.02 FILLED-SYSTEM THERMOMETERS
 - A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Trerice, H. O. Co.
 - c. Weiss Instruments, Inc.
 - 2. Standard: ASME B40.200.
 - 3. Case: Sealed type, cast aluminum or drawn steel; 5-inch (127-mm) nominal diameter.
 - 4. Element: Bourdon tube or other type of pressure element.
 - 5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
 - 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
 - 7. Pointer: Dark-colored metal.
 - 8. Window: plastic.
 - 9. Ring: Stainless steel.
 - 10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
 - 11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 - 12. Accuracy: Plus or minus 1 percent of scale range.

2.03 LIQUID-IN-GLASS THERMOMETERS

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

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Trerice, H. O. Co.
 - b. Weiss Instruments, Inc.
- 2. Standard: ASME B40.200.
- 3. Case: Cast aluminum; 7-inch (178-mm) nominal size unless otherwise indicated.
- 4. Case Form: Adjustable angle unless otherwise indicated.
- 5. Tube: Glass with magnifying lens and blue organic liquid.
- 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
- 7. Window: plastic.
- 8. Stem: Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
- 9. Connector: 1-1/4 inches (32 mm), 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.
- 2.04 THERMOWELLS
 - A. Thermowells:
 - 1. Standard: ASME B40.200.
 - 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - 3. Material for Use with Copper Tubing: CNR or CUNI.
 - 4. Material for Use with Steel Piping: CRES.
 - 5. Type: Stepped shank unless straight or tapered shank is indicated.
 - 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
 - 7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
 - 8. Bore: Diameter required to match thermometer bulb or stem.
 - 9. Insertion Length: Length required to match thermometer bulb or stem.
 - 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
 - 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
 - B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.05 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.

- b. Weiss Instruments, Inc.
- 2. Standard: ASME B40.100.
- 3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
- 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
- 5. Pressure Connection: Brass, with NPS 1/4 (DN 8), 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 and kPa.
- 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.

2.06 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), 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 (DN 8), ASME B1.20.1 pipe threads.

2.07 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trerice, H. O. Co.
 - 2. Weiss Instruments, Inc.
 - 3. Pete's Plugs.
- 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 1/4 (DN 8), ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- F. Core Inserts: EPDM self-sealing rubber.
- 2.08 TEST-PLUG KITS
 - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Trerice, H. O. Co.
- 2. Weiss Instruments, Inc.
- 3. Pete's Plugs.
- 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- (25- to 51mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).
- D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
- E. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter 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. 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.
- E. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- F. Install valve and snubber in piping for each pressure gage for fluids.
- G. Install test plugs in piping tees.
- H. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
- I. Install pressure gages in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each pressure-reducing valve.

3.02 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.
- 3.04 THERMOMETER SCHEDULE
 - A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
 - 1. Industrial-style, liquid-in-glass type.
 - B. Thermometer stems shall be of length to match thermowell insertion length.
- 3.05 THERMOMETER SCALE-RANGE SCHEDULE
 - A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).
 - B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).
- 3.06 PRESSURE-GAGE SCHEDULE
 - A. Pressure gages at discharge of each water service into building shall be one of the following:
 - 1. Liquid-filled, direct-mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.
 - B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
 - 1. Liquid-filled, direct-mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- 3.07 PRESSURE-GAGE SCALE-RANGE SCHEDULE
 - A. Scale Range for Water Service Piping: 0 to 160 psi (0 to 1100 kPa).

END OF SECTION

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Bronze ball valves.
 - 3. Bronze lift check valves.
 - 4. Bronze swing check valves.
 - 5. Bronze globe valves.
- B. Related Sections:
 - 1. Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
 - 2. Section 22 11 16 "Domestic Water Piping" for valves applicable only to this piping.
- 1.03 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.
- 1.04 ACTION SUBMITTALS
 - A. Product Data: For each type of valve indicated.

1.05 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.
- 1.06 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 and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Block check valves in either closed or open position.
 - B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
 - C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

- 2.01 GENERAL REQUIREMENTS FOR VALVES
 - A. Valves shall meet California Low Lead Legislation, AB 1953.
 - B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
 - C. Valve Sizes: Same as upstream piping unless otherwise indicated.
 - D. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

- E. Valve-End Connections:
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - 2. Threaded: With threads according to ASME B1.20.1.
- F. Valve Bypass and Drain Connections: MSS SP-45.
- 2.02 BRASS BALL VALVES
 - A. Two-Piece, Full-Port, Brass 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. Kitz Corporation.
 - d. Milwaukee Valve Company.
 - e. Or Equal.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.
- 2.03 BRONZE BALL VALVES
 - A. 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. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - f. Or Equal.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).

- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.
- B. Three-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. Conbraco Industries, Inc.; Apollo Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Three 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.
- 2.04 BRONZE SWING CHECK VALVES
 - A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Kitz Corporation.
 - d. NIBCO INC.
 - e. Red-White Valve Corporation.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - g. Or Equal.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig (1380 kPa).

- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

2.05 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Kitz Corporation.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - f. Or equal.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig (1380 kPa).
 - 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.

PART 3 - EXECUTION

- 3.01 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.

3.02 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. When possible, 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.

3.03 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.
- 3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS
 - A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, valves.
 - 2. Throttling Service: Globe or ball 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 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Threaded ends except where solder-joint valve-end option is indicated in valve schedules below .
- 3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE
 - A. Pipe NPS 2 (DN 50) and Smaller:
 - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two, full port, brass or bronze with stainless-steel trim.
 - 3. Bronze Swing Check Valves: Class 125, bronze disc.
 - 4. Bronze Globe Valves: Class 125, bronze disc.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to MEP Component Anchorage Notes for Piping, Ductwork, and Electrical Distribution System bracing on Sheet P0.10 of the Plumbing Drawings.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Metal 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:
 - 1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.03 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, 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.

1.05 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 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 stainless 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.
- C. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel stainless steel.
- 2.02 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.
- 2.03 METAL FRAMING SYSTEMS
 - A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
- g. Wesanco, Inc.
- 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
- 3. Standard: MFMA-4.
- 4. Channels: Continuous slotted steel channel with inturned lips.
- 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
- 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- 7. Metallic Coating: Electroplated zinc.
- 8. Paint Coating: Epoxy.

2.04 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carpenter & Paterson, Inc.
 - 2. Clement Support Services.
 - 3. ERICO International Corporation.
 - 4. National Pipe Hanger Corporation.
 - 5. PHS Industries, Inc.
 - 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 - 7. Piping Technology & Products, Inc.
 - 8. Rilco Manufacturing Co., Inc.
 - 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) 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 (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.05 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 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.

2.06 PIPE STANDS

- A. General Requirements for Pipe Stands: 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 Vshaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic.
 - 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:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 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 supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.
- 2.07 PIPE POSITIONING SYSTEMS
 - A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.
- 2.08 EQUIPMENT SUPPORTS
 - A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
- 2.09 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 (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 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. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.
- G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. 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.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. 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.
- O. 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 weightdistribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.

- 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- 3.02 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.
- 3.03 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.

3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).
- 3.05 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 (0.05 mm).

- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 91 13 "Exterior Painting" or Section 09 91 23 "Interior Painting."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- 3.06 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, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
 - F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
 - G. Use felt lined pipe hangers with EG 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 (DN 15 to DN 750).
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

- 7. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
- 8. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
- 9. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
- 10. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
- 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 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
- Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, 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 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- 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 (DN 24 to DN 600).
 - Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) 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 (150 mm) for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- 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 barjoist 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. C-Clamps (MSS Type 23): For structural shapes.
- 6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
- 7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
- 8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
- 9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
- 10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
- 11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- 12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- 13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- 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. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system 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.
- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.
- 1.03 ACTION SUBMITTALS
 - A. Product Data: For each type of product indicated.
 - B. Samples: For color, letter style, and graphic representation required for each identification material and device.
 - C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
 - D. Valve Schedules: For each piping system to include in maintenance manuals.

1.04 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

- 2.01 EQUIPMENT LABELS
 - A. Metal Labels for Equipment:

- 1. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
- 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- 3. Minimum Letter Šize: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- 4. Fasteners: Stainless-steel rivets or self-tapping screws.
- 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.02 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.
- 2.03 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 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.
- 2.04 STENCILS
 - A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.
- 2.05 VALVE TAGS
 - A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
 - 1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Stainless steel cable with clasp.
 - B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.06 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches (100 by 178 mm).
 - 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

3.01 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.
- 3.02 EQUIPMENT LABEL INSTALLATION
 - A. Install or permanently fasten labels on each major item of mechanical equipment.
 - B. Locate equipment labels where accessible and visible.
- 3.03 PIPE LABEL INSTALLATION
 - A. Piping Color-Coding: Painting of piping is specified in Section 09 91 23 "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 with painted, color-coded bands or rectangles 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 (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
 - D. Pipe Label Color Schedule:
 - 1. Per ANSI coloration for each system.

3.04 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience

and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches (38 mm), round.
 - b. Hot Water: 1-1/2 inches (38 mm), round.
 - 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - 3. Letter Color:
 - a. Cold Water: Black.
 - b. Hot Water: Black.
- 3.05 WARNING-TAG INSTALLATION
 - A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic hot-water piping.
 - 2. Supplies and drains for handicap-accessible lavatories and sinks.
 - 3. Condensate drain.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, watervapor permeance thickness, and jackets (both factory- and field-applied, if any).
- 1.04 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 smokedeveloped index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smokedeveloped index of 150 or less.
 - B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.
- 1.05 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.

1.06 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping installer for piping insulation application.
- 1.07 SCHEDULING
 - A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
 - B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," and "Indoor Piping 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, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide the following:
 - 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, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Ramco Insulation, Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Ramco Insulation, Inc.; Thermokote V.

2.03 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: Subject to compliance with requirements, provide the following:
 - 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. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. 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: Subject to compliance with requirements, provide the following:
 - 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; 85-20.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- 3. 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."
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - 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. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. 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."
- 2.04 SEALANTS
 - A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 1. Products: Subject to compliance with requirements, provide the following:
 - 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 (Minus 40 to plus 121 deg C).
 - 5. Color: White.
 - 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 7. Sealants 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."

2.05 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.

2.06 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, provide 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.
 - 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.

2.07 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - 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 (75 mm).
 - 3. Thickness: 11.5 mils (0.29 mm).
 - 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

- 1. Products: Subject to compliance with requirements, provide the following:
 - 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 (75 mm).
- 3. Thickness: 6.5 mils (0.16 mm).
- 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
- 5. Elongation: 2 percent.
- 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
- 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 - 2. Width: 2 inches (50 mm).
 - 3. Thickness: 6 mils (0.15 mm).
 - 4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 - 5. Elongation: 500 percent.
 - 6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
- 2.08 SECUREMENTS
 - A. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
 - B. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire.

2.09 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers, :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Plumberex.
 - b. Truebro; a brand of IPS Corporation.

- 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements. Comply with ASTM E84.
- B. Protective Shielding Piping Enclosures, :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Truebro; a brand of IPS Corporation.
 - 2. Description: Manufactured plastic enclosure for covering plumbing fixture hotand cold-water supplies and trap and drain piping. Comply with ADA requirements. Comply with ASTM E84.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 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- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.

- 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) 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 (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.

- 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
- 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
- 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.05 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 (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 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.

3.07 INSTALLATION OF MINERAL-FIBER 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 (150 mm) 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 (25 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
 - 3. Fiberglass inserts with preformed PVC fitting covers/
- 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.

3.08 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.
- 3.09 FINISHES
 - A. Insulation with ASJ, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

- 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.
- 3.10 FIELD QUALITY CONTROL
 - A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - B. Perform tests and inspections.
 - C. Tests and Inspections:
 - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, 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, as defined in the "Piping Insulation Schedule, General" Article.
 - D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
- 3.11 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.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot Water:
 - 1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
 - b. NPS 1 ½ and larger: Mineral-Fiber Pipe Insulation, Type 1: 1 ½ inch thick.
- B. Condensate Drain:
 - 1. Flexible Elastomeric: 3/4 inch (19 mm) thick.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
 - 2. Encasement for piping.
- 1.03 ACTION SUBMITTALS
 - A. Product Data: For transition fittings and dielectric fittings.

PART 2 - PRODUCTS

- 2.01 PIPING MATERIALS
 - A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
 - B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."
- 2.02 COPPER TUBE AND FITTINGS
 - A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
 - B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.
 - C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - E. Flanges: ANSI B16.5 and ASME B16.22, Class 150, with solder-joint ends.

- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.

2.03 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. 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.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- 2.04 ENCASEMENT FOR PIPING
 - A. Standard: ASTM A 674 or AWWA C105/A21.5.
 - B. Form: Sheet or tube.
 - C. Color: Black.
- 2.05 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 the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Piping Specialties Products.
 - c. Ford Meter Box Company, Inc. (The).

- d. JCM Industries.
- e. Romac Industries, Inc.
- f. Smith-Blair, Inc.; a Sensus company.
- g. Viking Johnson.
- h. Or equal.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
 - d. Or equal.
 - 2. Description:
 - a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket end.

2.06 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: Subject to compliance with requirements, provide products by the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International.
 - e. Matco-Norca.
 - f. McDonald, A. Y. Mfg. Co.
 - g. Watts; a division of Watts Water Technologies, Inc.
 - h. Wilkins; a Zurn company.
 - i. Or equal.
 - 2. Standard: ASSE 1079.
 - 3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C.
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Elster Perfection Corporation.
- b. Grinnell Mechanical Products; Tyco Fire Products LP.
- c. Matco-Norca.
- d. Precision Plumbing Products, Inc.
- e. Victaulic Company.
- f. Or equal.
- 2. Standard: IAPMO PS 66.
- 3. Electroplated steel nipple complying with ASTM F 1545.
- 4. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
- 5. End Connections: Male threaded or grooved.
- 6. Lining: Inert and noncorrosive, propylene.
- D. Dielectric Flange:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Elkhart
 - b. CTS
 - c. Nlbco

PART 3 - EXECUTION

- 3.01 EARTHWORK
 - A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.
- 3.02 PIPING INSTALLATION
 - A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
 - B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
 - C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
 - D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at domestic water-service entrance. Comply with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties."
 - E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."

- F. Install domestic water piping level with manufacturers and plumb.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install seismic restraints on piping. Comply with local code requirements.
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- 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 above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the 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.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "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 22 05 17 "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 22 05 18 "Escutcheons for Plumbing Piping."
- 3.03 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 for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: 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. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.
- 3.04 TRANSITION FITTING INSTALLATION
 - A. Install transition couplings at joints of dissimilar piping.
 - B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.
 - C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings.
- 3.05 DIELECTRIC FITTING INSTALLATION
 - A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.
- 3.06 HANGER AND SUPPORT INSTALLATION
 - A. Comply with local code requirements for seismic-restraint devices.Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
 - 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 (10 mm).
 - D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.

- 2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
- 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
- 4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
- 5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
- E. Install supports for vertical copper tubing every 10 feet (3 m).
- F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for 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. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.08 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.
- 3.09 FIELD QUALITY CONTROL
 - A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. 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:

- 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
- Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are holding pressure, air or water.
 - b. 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.
 - c. 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.
 - d. Cap and subject piping to pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- 3.10 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 hot-water flow 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.

3.11 CLEANING

- A. Clean and disinfect 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 (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Clean non-potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller , shall be the following:
 - 1. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
- E. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
 - 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper, solder-joint fittings; and soldered joints.
- F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be the following:
 - 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B)wrought-copper, solder-joint fittings; and soldered joints.

3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball valves for piping NPS 2 (DN 50) and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 - 3. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Strainers.
 - 5. Outlet boxes.
 - 6. Hose bibbs.
 - 7. Drain valves.
 - 8. Water-hammer arrestors.
 - 9. Trap-seal primer valves.
 - 10. Specialty valves.
 - 11. Flexible connectors.
- B. Related Requirements:
 - 1. Section 22 11 16 "Domestic Water Piping" for water meters.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- 1.04 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

- 2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES
 - A. Potable-water piping and components shall comply with NSF 61, and NSF 14, California Legislation AB 9153, Low Lead content.

2.02 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

2.03 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following
 - a. Cash Acme; a division of Reliance Worldwide Corporation.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; a division of Watts Water Technologies, Inc.
 - d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - f. Or equal.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Rough bronze.
- B. Hose-Connection Vacuum Breakers :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following
 - a. Cash Acme; a division of Reliance Worldwide Corporation.
 - b. Conbraco Industries, Inc.
 - c. MIFAB, Inc.
 - d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - e. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - g. Or equal.
 - 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: Rough bronze.

2.04 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers :

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; a division of Watts Water Technologies, Inc.
 - d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - f. Or equal.
- 2. Standard: ASSE 1013.
- 3. Operation: Continuous-pressure applications.
- 4. Pressure Loss: 10 psig (83 kPa) maximum, through middle third of flow range.
- 5. Body: Bronze for NPS 2 (DN 50) and smaller; stainless steel for NPS 2-1/2 (DN 65) and larger.
- 6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
- 7. Configuration: Designed for horizontal, straight-through flow.
- 8. Accessories:
 - a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
 - d. Or equal.

2.05 WATER PRESSURE-REDUCING VALVES

- A. Water Regulators:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following
 - a. Cash Acme; a division of Reliance Worldwide Corporation.
 - b. Conbraco Industries, Inc.
 - c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - 2. Standard: ASSE 1003.
 - 3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
 - 4. Size: NPS 2 (DN 50)>.
 - 5. Design Inlet Pressure: 5 psig (35 kPa).
 - 6. Design Outlet Pressure Setting: <80 psig (552 kPa).
 - 7. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

8. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

2.06 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers :
 - 1. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
 - 2. Body: Bronze for NPS 2 (DN 50) and smaller; cast bronze.
 - 3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 - 4. Screen: Stainless steel with round perforations unless otherwise indicated.
 - 5. Perforation Size:
 - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
 - b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
 - 6. Drain: Factory-installed, hose-end drain valve.

2.07 HOSE BIBBS

- A. Hose Bibbs :
 - 1. Standard: ASME A112.18.1 for sediment faucets.
 - 2. Body Material: Bronze.
 - 3. Seat: Bronze, replaceable.
 - 4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solderjoint inlet.
 - 5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
 - 6. Pressure Rating: 125 psig (860 kPa).
 - 7. Vacuum Breaker: Integral nonremovable, 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: Rough bronze.
 - 10. Finish for Finished Rooms: Chrome or nickel plated.
 - 11. Operation for Equipment Rooms: Wheel handle or operating key.
 - 12. Operation for Service Areas: Operating key.
 - 13. Operation for Finished Rooms: Operating key.
 - 14. Include operating key with each operating-key hose bibb.
 - 15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.08 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves :
 - 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
 - 2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
 - 3. Size: NPS 3/4 (DN 20).
 - 4. Body: Copper alloy.
 - 5. Ball: Chrome-plated brass.
 - 6. Seats and Seals: Replaceable.

- 7. Handle: Vinyl-covered steel.
- 8. Inlet: Threaded or solder joint.
- 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.09 WATER-HAMMER ARRESTORS

- A. Water-Hammer Arrestors :
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Precision Plumbing Products, Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products.
 - i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
 - j. Or equal.
 - 2. Standard: ASSE 1010 or PDI-WH 201.
 - 3. Type: Metal bellows or Copper tube with piston.
 - 4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.
- 2.10 TRAP-SEAL PRIMER DEVICE
 - A. Supply-Type, Trap-Seal Primer Device :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. MIFAB, Inc.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - f. Or equal.
 - 2. Standard: ASSE 1018.
 - 3. Pressure Rating: 125 psig (860 kPa) minimum.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
 - 6. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
 - 7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished. Gravity from flush valve or sink trap arm as manufactures by Sloan, JR Smith, Zurn, or equal.

2.11 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Flex-Hose Co., Inc.
 - 2. Flexicraft Industries.
 - 3. Hyspan Precision Products, Inc.
 - 4. Metraflex, Inc.
 - 5. Unaflex.Universal Metal Hose; a Hyspan company.
 - 6. Or equal.
- 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 (1380 kPa).
 - 2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plainend copper tube.
 - 3. End Connections NPS 2-1/2 (DN 65) 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 (1380 kPa).
 - 2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
 - 3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. 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 unacceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves and bypass with memorystop balancing valve. Install pressure gages on inlet and outlet.
- C. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
- D. Install water-hammer arresters in water piping according to PDI-WH 201.

- E. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- 3.02 CONNECTIONS
 - A. Comply with requirements for ground equipment in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 - B. Fire-retardant-treated-wood blocking is specified in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.
- 3.04 ADJUSTING
 - A. Set field-adjustable pressure set points of water pressure-reducing valves.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Hubless, cast-iron soil pipe and fittings.
 - 2. Copper tube and fittings.
 - 3. PVC pipe and fittings.
 - 4. Specialty pipe fittings.

1.03 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 (30 kPa).
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- 1.04 ACTION SUBMITTALS
 - A. Product Data: For each type of product indicated.
- 1.05 QUALITY ASSURANCE
 - A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
 - B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

- 2.01 PIPING MATERIALS
 - A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Fernco Inc.
 - c. MIFAB, Inc.
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. Or Equal.
 - 2. Standards: ASTM C 1277 and CISPI 310.
 - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- 2.03 COPPER TUBE AND FITTINGS
 - A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 - B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
 - C. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B and Type C), water tube, drawn temper.
 - D. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestosfree, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
 - E. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.
- 2.04 PVC PIPE AND FITTINGS
 - A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 - C. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive primer 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. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Solvent cement 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."

2.05 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Fernco Inc.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - 3) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - 4) Or equal.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - 4. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - 3) Or equal.

- b. Standard: ASTM C 1460.
- c. Description: Elastomeric or rubber sleeve with full-length, corrosionresistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."
- 3.02 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 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 at indicated slopes.
 - F. Install piping free of sags and bends.
 - G. Install fittings for changes in direction and branch connections.
 - H. Install seismic restraints on piping. Comply with local code requirements for seismic-restraint devices.
 - I. 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 two 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 135 degrees before a cleanout. 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.
 - J. Install true to grades and alignment indicated.

- K. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: Level.
- L. 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/A 21.5.
- M. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- N. Install underground PVC piping according to ASTM D 2321.
- O. Plumbing Specialties:
 - Install backwater valves in sanitary waster gravity-flow piping (if required). Comply with requirements for backwater valves specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
 - 3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
- P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install sleeve seals for piping penetrations of concrete walls where exposed to view. Comply with requirements for sleeve seals specified in Section 22 05 17 "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 22 05 18 "Escutcheons for Plumbing Piping."
- 3.03 JOINT CONSTRUCTION
 - A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

- B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- D. Plastic, Nonpressure-Piping, Solvent-Cement 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. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.05 VALVE INSTALLATION

- A. General valve installation requirements are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."
- B. Backwater Valves: Install backwater valves in piping subject to backflow (if required).
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 - 2. Install backwater valves in accessible locations.
 - 3. Comply with requirements for backwater valve specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

3.06 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.

- 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
- 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
- B. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
 - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
 - 4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
- H. Install supports for vertical copper tubing every 10 feet (3 m).
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.07 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. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
- 5. Install horizontal backwater valves with cleanout cover flush with floor.
- 6. Comply with requirements for backwater valves, cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- 3.08 IDENTIFICATION
 - A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
- 3.09 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 test medium, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: Allow water to run through fixture and connections noting if there are leaks. If leaks occur, fix and retest by running water through the fixture.

- 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- 6. Prepare reports for tests and required corrective action.
- 3.10 CLEANING AND PROTECTION
 - 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.
 - D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint by painting contractor.
- 3.11 PIPING SCHEDULE
 - A. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following: another.
 - 1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
 - B. Aboveground, condensate drain piping shall be any of the following:
 - 1. Copper Type 'M' tube, standard copper sweat fittings, and soldered joints.
 - C. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
 - D. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be the following:
 - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Floor Sinks.
 - 3. Roof flashing assemblies.
 - 4. Through-penetration firestop assemblies.
 - 5. Miscellaneous sanitary drainage piping specialties.
 - 6. Flashing materials.

1.03 DEFINITIONS

- A. FOG: Fats, oils, and greases.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- 1.04 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.

1.05 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.01 CLEANOUTS

- A. Exposed Metal Cleanouts :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - e. Or equal.
 - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk or raised-head, cast-iron plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 7. Closure: brass or plastic PVC/ABS plug with seal.
- B. Metal Floor Cleanouts :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 - d. Or equal.
 - 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
 - 3. Size: Same as connected branch.
 - 4. Type: Cast-iron soil pipe with cast-iron ferrule.
 - 5. Body or Ferrule: Cast iron.
 - 6. Clamping Device: Required.
 - 7. Outlet Connection.
 - 8. Closure: brass or plaxtic PVC/ABS straight threads and gasket.
 - 9. Adjustable Housing Material: Cast iron with set-screws or other device.
 - 10. Frame and Cover Material and Finish: Bronze.
 - 11. Frame and Cover Shape: Round.
 - 12. Top Loading Classification: Medium Duty.
 - 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

- C. Wall Cleanouts :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; d of Smith Industries, Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 - d. Or equal to include Hold Rite Testrite test tee.
 - 2. Standard: ASME A112.36.2M. Include wall access.
 - 3. Size: Same as connected drainage piping.
 - 4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk or raised-head, brass plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 7. Wall Access: Round, stainless-steel cover plate with screw.

2.02 FLOOR SINKS FS-1.

- A. Cast-Iron Floor Sinks:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 - d. Or equal.
 - 2. Standard: ASME A112.6.3.
 - 3. Pattern: Floor sink.
 - 4. Body Material: Gray iron.
 - 5. Seepage Flange: Required.
 - 6. Anchor Flange: Required.
 - 7. Clamping Device: Required.
 - 8. Outlet: Bottom.
 - 9. Backwater Valve: Not required.
 - 10. Coating on Interior and Exposed Exterior Surfaces: N/A.
 - 11. Sediment Bucket: Not required.
 - 12. Top of Body and grate: Nickel bronze.
 - 13. Top Shape: Square.
 - 14. Top Loading Classification: Medium Duty.
 - 15. Funnel: Not required.
 - 16. Inlet Fitting: trap-seal primer valve connection on trap below.

2.03 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies :

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
 - c. Or equal.
- B. Description: Manufactured assembly made of stainless steel flashing collar and skirt extending at least 8 inches (200 mm) from pipe, with counterflashing fitting.
 - 1. Open-Top Vent Cap: Without cap.

2.04 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.
 - b. Or equal.
 - 2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
 - 3. Size: Same as connected soil, waste, or vent stack.
 - 4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
 - 5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
 - 6. Special Coating: Corrosion resistant on interior of fittings.
- 2.05 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 (DN 15) 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.

2.06 FLASHING MATERIALS

- A. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- B. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 90 degrees.
 - 3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
 - b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
 - c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

- 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- H. Install through-penetration firestop assemblies in plastic stacks at floor penetrations.
- I. Assemble open drain fittings and install with top of hub 2 inches (51 mm) 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 wood-blocking reinforcement for wall-mounting-type specialties.
- O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- 3.02 CONNECTIONS
 - A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
 - B. Install piping adjacent to equipment to allow service and maintenance.

3.03 FLASHING INSTALLATION

- A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

- B. Secure flashing into sleeve and specialty clamping ring or device.
- C. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00 "Sheet Metal Flashing and Trim."
- D. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- 3.04 LABELING AND IDENTIFYING
 - A. As specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.05 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.06 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Roof drains.
 - 2. Overflow Drains
 - 3. Miscellaneous storm drainage piping specialties.
 - 4. Cleanouts.
 - 5. Through-penetration firestop assemblies.
 - 6. Flashing materials.
- 1.03 ACTION SUBMITTALS
 - A. Product Data: For each type of product indicated.
- 1.04 QUALITY ASSURANCE
 - A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- PART 2 PRODUCTS
- 2.01 METAL ROOF DRAINS
 - A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 - d. Or equal.
 - 2. Standard: ASME A112.6.4, for general-purpose roof drains.
 - 3. Body Material: Cast iron.
 - 4. Dimension of Body: Nominal 14-inch (357-mm) diameter.
 - 5. Combination Flashing Ring and Gravel Stop: Required.

- 6. Flow-Control Weirs: Not required.
- 7. Outlet: Bottom.
- 8. Extension Collars: Required.
- 9. Underdeck Clamp: Required.
- 10. Expansion Joint: Not required.
- 11. Sump Receiver Plate: Required.
- 12. Dome Material: Cast iron.
- 13. Perforated Gravel Guard: Not required.
- 14. Vandal-Proof Dome: Not required.
- B. Cast-Iron, Large-Sump, General-Purpose Overflow Roof Drains:
 - 1. Same as RD-1 except with 2-inch water dam.

2.02 CLEANOUTS

- A. Wall Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 - d. Or equal.
 - 2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
 - 3. Size: Same as connected drainage piping.
 - 4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk or raised-head, plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.03 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.
 - b. Or equal.
 - 2. Standard: ASTM E 814, for through-penetration firestop assemblies.
 - 3. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
 - 4. Size: Same as connected pipe.

- 5. 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.
- 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. Special Coating: Corrosion resistant on interior of fittings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- B. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 90 degrees.
 - 3. Locate cleanouts at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
 - 4. Locate cleanouts 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 wall cleanouts in vertical conductors. Install access door in wall if indicated.
- F. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.
- G. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.02 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 14 13 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- 3.03 FLASHING INSTALLATION
 - A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following manufacturer or drain flashing.

3.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 34 00

FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Commercial, atmospheric, gas-fired, storage, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.
- 1.04 INFORMATIONAL SUBMITTALS
 - A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.
 - B. Seismic Qualification Data: Certificates, for fuel-fired, domestic-water heaters, 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. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
 - D. Source quality-control reports.
 - E. Field quality-control reports.

- F. Sample Warranty: For special warranty.
- 1.05 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.
- 1.06 COORDINATION
 - A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- 1.07 WARRANTY
 - A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: One year(s).
 - b. Expansion Tanks: Five years.

PART 2 - PRODUCTS

- 2.01 PERFORMANCE REQUIREMENTS
 - A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
 - B. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Component Importance Factor: 1.0.
 - C. ASHRAE/IES Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IES 90.1.
 - D. ASME Compliance:

- 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.
- 2.02 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS
 - A. Commercial, Atmospheric, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1. AO Smith BT-80
 - 2. Or Approved Equal
 - 3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
 - 4. Standard: ANSI Z21.10.3/CSA 4.3.
 - 5. Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
 - NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Glass complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
 - 6. Factory-Installed, Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - d. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner: For use with atmospheric, gas-fired, domestic-water heaters and natural-gas fuel.

- g. Ignition: Standing pilot or ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
- h. Temperature Control: Adjustable thermostat.
- i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
- j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.
- 7. Special Requirements: NSF 5 construction.
- 8. Draft Hood: Draft diverter, complying with ANSI Z21.12.
- B. Capacity and Characteristics:
 - 1. Capacity: 74 gal.
 - 2. Recovery: 104 gph at 70 deg F temperature rise.
 - 3. Temperature Setting: 120 deg F.
 - 4. Fuel Gas Demand: 75.1 cfh.
 - 5. Fuel Gas Input: 75,100 Btu/h.
 - 6. Minimum Vent Diameter: 4 inches.

2.03 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Expansion Tanks:
 - 1. Taco
 - 2. Amtrol
 - 3. Or Approved Equal
 - 4. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
 - 5. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 6. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - 7. Capacity and Characteristics:
 - a. Working-Pressure Rating: 150 psig (1035 kPa).
 - b. Capacity Acceptable: 2 gal. (7.6 L) minimum.

- c. Air Precharge Pressure: 80 psi.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads.
- C. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
 - 1. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."
- D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1, manually operated. Furnish for installation in piping.
- E. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig (3.5kPa) pressure rating as required to match gas supply.
- F. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- G. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.
- H. Pressure Relief Valves: Include pressure setting less than working-pressure rating of domestic-water heater.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.
- I. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.
- 2.04 SOURCE QUALITY CONTROL
 - A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
 - B. Hydrostatically test commercial domestic-water heaters to minimum of one and onehalf times pressure rating before shipment.
 - C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
 - D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Install domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
- C. Install gas-fired, domestic-water heaters in accordance with NFPA 54.
 - 1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 - 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 - 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
 - 4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."
- D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" and Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- G. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- H. Fill domestic-water heaters with water.
- I. Charge domestic-water expansion tanks with air to required system pressure.
- J. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.
- 3.02 PIPING CONNECTIONS
 - A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
 - B. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."
 - C. Drawings indicate general arrangement of piping, fittings, and specialties.
 - D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.
- 3.03 IDENTIFICATION
 - A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
- 3.04 FIELD QUALITY CONTROL
 - A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
 - B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.
- 3.05 DEMONSTRATION
 - A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage domestic-water heaters. Training shall be a minimum of one hour(s).

END OF SECTION
SECTION 22 42 16.16

COMMERCIAL SINKS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Service sinks.
 - 2. Utility Sinks
 - 3. Sink faucets.
 - 4. Supply fittings.
 - 5. Waste fittings.
- B. Related Requirements:
 - 1. Section 22 40 00 "Plumbing Fixtures" for residential sinks.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sinks to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 SERVICE SINKS

- A. Service Sinks MS-1: Molded high density composite basin, floor mounted.
 - 1. Zurn
 - 2. Kohler
 - 3. American Standard
 - 4. Or approved equal.
 - 5. Fixture:
 - a. Standard: ANZI Z124.6

- b. Style: Floor mounted square.
- c. Nominal Size: 24 by 24 inches.
- d. Color: White.
- e. Drain: Grid with NPS 3 (DN 80) outlet.
- f. Rim Guard: None.
- 6. Faucet: MS-1.
- 2.02 UTILITY SINKS
 - A. Utility Sinks S-2: Stainless steel, freestanding.
 - 1. Advance Tabco 6-1-24 Series 600
 - 2. Or Approved Equal
 - 3. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: With backsplash.
 - c. Number of Compartments: One.
 - d. Overall Dimensions: 21 x 24 x 24-1/2.
 - e. Metal Thickness: 0.050 inch (1.3 mm).
 - f. Compartment:
 - 1) Drain: Grid with NPS 2 (DN 50) tailpiece and twist drain.
 - 2) Drain Location: Near back of compartment.
 - g. Drainboard(s): Not required.
 - 4. Supports: Adjustable-length steel legs.
 - 5. Faucet(s): S-2.
 - a. Number Required: One.
 - b. Mounting: On backsplash.
 - 6. Supply Fittings:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - 1) Operation: Loose key.
 - 2) Risers: NPS 1/2 (DN 15), chrome-plated, rigid-copper pipe.
 - 7. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap(s):
 - 1) Size: NPS 2 (DN 50).

- 2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall thick brass tube to wall and chrome-plated brass or steel wall flange.
- c. Continuous Waste:
 - 1) Size: NPS 2 (DN 50).
 - 2) Material: Chrome-plated, 0.032-inch- (0.83-mm-) thick brass tube.

2.03 HANDWASH SINKS

- A. Handwash Sinks S-1: Stainless steel, wall mounted.
 - 1. Just HCL-23520-S
 - 2. Or Approved Equal.
 - 3. Fixture:
 - a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
 - b. Type: Basin with radius corners, back for faucet, and support brackets.
 - c. Nominal Size: 23.5 x 20 x 4 inches.
 - 4. Faucet: Furnish with sink as an option.
 - 5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
 - 6. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
 - 7. Support: Type II sink carrier.
 - 8. Lavatory Mounting Height: Handicapped/elderly according to ICC A117.1.

2.04 SINK FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components Health Effects," for faucet-spout materials that will be in contact with potable water.
- B. Sink Faucets MS-1: Manual type, two-lever-handle mixing valve.
 - 1. Commercial, Solid-Brass Faucets.
 - a. Zurn.
 - b. Speakman
 - c. Chicago
 - d. Or approved equal.
 - 2. Standard: ASME A112.18.1/CSA B125.1.
 - 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 - 4. Body Type: Widespread.
 - 5. Body Material: Commercial, solid brass.
 - 6. Finish: Chrome plated.
 - 7. Maximum Flow Rate: 2.2 gpm (8.3 L/min.).

- 8. Handle(s):2 1/2 " color coded lever.
- 9. Mounting Type: Back/wall, exposed.
- 10. Spout Type: Rigid, solid brass with wall brace.
- 11. Vacuum Breaker: Required for hose outlet.
- 12. Spout Outlet: Hose thread according to ASME B1.20.7.

2.05 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- 2.06 WASTE FITTINGS
 - A. Standard: ASME A112.18.2/CSA B125.2.
 - B. Drain: Grid type with NPS 1-1/2 (DN 40) offset and straight tailpiece.

2.07 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 (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.02 INSTALLATION
 - A. Install sinks level and plumb according to roughing-in drawings.
 - B. Set floor-mounted sinks in leveling bed of cement grout.

- C. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- D. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- E. Plumbing fixtures and accessories provided in a toilet room or bathing room required to comply with CBC Section 11B-213.2 shall comply with CBC Section 11B-213.3.
- F. Effective March 1, 2017, all single-user toilet facilities shall be identified as Gender Neutral facilities by a door symbol that complies with CBC Sections 11B-216.8 and 11B-703.7.2.6.3 No pictogram, text or braille is required on the symbol. If tactile jamb signage is provided, the signage shall comply with the appropriate technical requirements of CBC Section 11B-703. Examples of appropriate designations are "ALL-GENDER RESTROOM", "RESTROOM", or "UNISEX RESTROOM". DSA BU 17-01.
- G. Accessible plumbing fixtures shall comply with all the requirements in CBC Division 6.
- H. Clearance around accessible water closets and in toilet compartments shall be 60 inches minimum measured perpendicular from the side wall and 56 inches minimum measured perpendicular from the rear wall per CBC Section 11B-604.3.1.
- I. Heights and location of all accessible fixtures shall be mounted according to CBC Sections 11B-602 through 11B-612.
- J. Accessible fixture controls shall comply with CBC Sections 11B-602.3 for drinking fountains, 11B-604.6 for water closets, 11B-604.9.5 for childrens water closets, 11B-605.4 for urinals, 11B-606.4 for lavatories and sinks, 11B-607.5 for bathtubs, 11B-608.5 for showers, and 11B-611.3 for washing machines and clothesdryers.

3.03 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.04 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.05 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Combination units.
 - 2. Supplemental equipment.
 - 3. Water-tempering equipment.

1.03 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Tepid: Moderately warm.
- 1.04 ACTION SUBMITTALS
 - A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- 1.05 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.
- 1.06 MAINTENANCE MATERIAL SUBMITTALS
 - A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushing-Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ISEA Standard: Comply with ISEA Z358.1.
- C. NSF Standard: Comply with NSF 61 and NSF 372, for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC A117.1; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

2.02 COMBINATION UNITS

- A. Accessible, Plumbed Emergency Shower with Eyewash Combination Units, EEWSH-1:
 - 1. Guardian GBF-1994
 - 2. Or Approved Equal
 - 3. Piping:
 - a. Material: Chrome-plated brass or stainless steel.
 - b. Unit Supply: NPS 1-1/4 (DN 32) minimum.
 - c. Unit Drain: Outlet at back or side near bottom.
 - 4. Shower:
 - a. Capacity: Not less than 20 gpm (76 L/min.) for at least 15 minutes.
 - b. Supply Piping: NPS 1 (DN 25) with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod.
 - d. Shower Head: 8-inch- (200-mm-) minimum diameter, chrome-plated brass or stainless steel.
 - e. Mounting: Pedestal.
 - 5. Eyewash Unit:
 - a. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless-steel bowl.
 - f. Mounting: Attached shower pedestal.
 - 1) Mounting: Bracket on shower pedestal.

2.03 WATER-TEMPERING EQUIPMENT

- A. Hot- and Cold-Water, Water-Tempering Equipment, EEWSH-1:
 - 1. Guardian G3800LF
 - 2. Or Approved Equal.
 - 3. Description: Factory-fabricated equipment with thermostatic mixing valve.
 - a. Thermostatic Mixing Valve: Designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
 - b. Supply Connections: For hot and cold water.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for water piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.02 INSTALLATION OF EMERGENCY PLUMBING FIXTURE INSTALLATION
 - A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
 - B. Install fixtures level and plumb.
 - C. Fasten fixtures to substrate.
 - D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of the equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."
 - 1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
 - 2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
 - E. 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."

- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- J. Fill self-contained fixtures with flushing fluid.

3.03 CONNECTIONS

- A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."
- B. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.04 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.05 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. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- 3.06 ADJUSTING
 - A. Adjust or replace fixture flow regulators for proper flow.
 - B. Adjust equipment temperature settings.

END OF SECTION

SECTION 23 00 10

MECHANICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The General Conditions and Supplementary Conditions shall apply to and form part of this Division.
- B. Refer to DSA anchorage notes on sheet M0.01.

1.02 SUMMARY

- A. Work includes, but is not limited to, the following:
 - 1. Labor, material, equipment and transportation to complete the Work as shown on the drawings, specified herein and/or implied thereby.
 - 2. A requirement of the plumbing sections shall be to provide make-up water and drain final connections to systems and equipment.
 - 3. It is the intent of the project that the installation be coordinated to provide the various complete and usable mechanical systems for Palomar's HVAC program for demonstration and training purposes.
- B. Work not included in this division:
 - 1. Painting, except as hereinafter specified. See Division 9 for painting.
 - 2. Electrical, except for controls hereinafter specified. See Division 26 for electrical.
- C. Related Sections include the following:
 - 1. Division 00 and 01: Procurement and Contracting Requirements and General Requirements
 - 2. Division 22: Plumbing.
 - 3. Division 26: Electrical

1.03 DEFINITIONS

- A. Unless otherwise specified, "all clarification from," "field direction by," "submittals to," "approved by," "processed by," "permission from," and like mentioned herein shall mean from/by/to Architect.
- B. "Provide" means furnish and install referenced item with all appurtenances.
- C. "Shall" indicates a mandatory requirement.
- D. "Air conditioning" is defined as the treatment and/or handling of any air to any degree by the systems shown on the drawings and herein specified and is not restricted to refrigerated cooling.

1.04 DELIVERY AND STORAGE OF MATERIALS

- A. Palomar has purchased some of the mechanical equipment. Refer to the Mechanical Schedule in the design documents. Coordinate the procurement of the equipment prior to installation.
- B. Provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage from any cause whatever and provide adequate and proper storage facilities during the progress of the work.
 - 1. Contractor to document any existing damages and defections prior to taking responsibility to relocate, store and install the equipment.
 - 2. Properly protect all openings to equipment, piping, ductwork, accessories, etc. from dirt, dust, and debris prior to and during installation of the work. Ductwork stored at the jobsite shall be covered to protect from dirt, dust, debris, fire proofing, etc.

1.05 CODES AND STANDARDS

- A. Work and materials shall be in full accordance with the latest rules and regulations of the Local Fire Marshal; the National Electric Code (NEC); the Uniform Plumbing Code; the California Plumbing Code; California Administrative Code, Title 24, (CAL/OSHA); Local Building Codes; the Uniform Mechanical Code; the California Mechanical Code; Vol. II of the Uniform Building Code; Volume I and II of the California Building Code; SMACNA "Guidelines for Seismic Restraints of Mechanical Systems"; and other applicable codes, laws or regulations of bodies lawfully empowered and having jurisdiction over this project.
 - 1. Nothing in the plans or specifications shall be construed to permit work not conforming to these codes. When codes conflict with one another, provide larger, higher or more restrictive standards without additional costs.

1.06 PERMITS

A. Obtain all permits, patent rights, and licenses that are required for the performing of this work by all laws, ordinances, rules and regulations, or orders of any officer and/or body. Provide all notices necessary in connection therewith, and pay all fees relating thereto and all costs and expenses incurred on account thereof. No work shall be covered before inspection by the jurisdictional authorities and observation by the Architect or the owner's designated representatives.

1.07 EXPLANATION AND PRECEDENCE OF DRAWINGS

- A. Drawings and specifications are intended to be read together so that any work mentioned in one and not the other shall be executed the same as if mentioned in both.
- B. For purposes of clearness and legibility, drawings are essentially diagrammatic. The size and location of equipment is drawn to scale wherever possible. Contractor shall make use of data in the contract documents and shall verify this information at the building site.

- C. Where the contract specifications and/or drawings are in conflict, obtain clarification of such during bidding. Where addenda for clarification of such is not timely, base the bid on the higher standards or more restrictive requirements; prior to fabrication, obtain written clarification.
- D. The drawings indicate required size and points of termination of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. It is not intended that drawings indicate necessary offsets. The Contractor shall make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or costs to the Owner.
- E. It is intended that apparatus be located symmetrical with the other mechanical equipment and architectural and structural elements. Refer to architectural details in completing the correlating work.
- F. The Contractor shall study drawings and specifications including, and not limited to, architectural, structural, mechanical, plumbing and electrical to determine conflict with ordinances and statutes. Errors or omissions shall be reported in writing, and changes shall be included in the as-built drawings and the additional work performed at no cost to the Owner.
- G. Submittal of bid shall indicate the Contractor has examined the site and drawings and has included required allowances in his bid. No allowance shall be made for any error resulting from Contractor's failure to visit job site and to review drawings and specifications. Bid shall include costs for required drawings and changes as outline above, all at no cost to owner.

1.08 RECORD DRAWINGS

- A. In addition, for requirements for shop drawings specified elsewhere, provide and maintain on the job one complete set of prints of the record drawings for all the mechanical and plumbing work. Carefully record on this set of prints, work including piping, valves, etc., which is installed differently from that indicated in the specifications and on the drawings; locate dimensionally from fixed points. The depth shall be indicated for all plugged wyes, tees and capped lines.
- B. These record drawings shall be continuously kept up-to-date and shall be available for inspection at all times. Existing lines discovered shall be indicated on these drawings.
- C. At completion of work, provide a neat and legible reproducible set of these up-to-date record drawings which shall be individually signed and dated by the Contractor and the job inspector as to their accuracy.
- D. Record drawings shall be submitted for acceptance and approval to the Architect and Mechanical Engineer before final certificate of acceptance will be issued.
- E. Record drawings shall show the exact location of all control sensor devices.

1.09 CUTTING AND PATCHING

- A. Perform all cutting and fitting required for work of this section in rough construction of the building. Obtain permission of the Structural Engineer prior to cutting any structural building elements.
- B. All patching of finished construction of building shall be performed under the sections of specifications covering these materials by the trades at no additional cost to the Owner.
- C. All cutting of concrete work by Contractor shall be by core drilling or concrete saw. No cutting or coring shall be done without first obtaining the permission of the Architect and Owner.
- D. All patching of existing surfaces shall match existing material and finish.

1.10 DAMAGE BY LEAKS

A. Contractor shall be responsible for damage to the grounds, walks, roads, buildings, finishes, surfaces, materials, equipment, piping systems, electrical systems and their equipment and contents, caused by leaks in the piping systems being installed or having been installed herein. He shall repair at his expense all damage so caused. All repair work shall be done as directed by the Architect and Owner.

1.11 EMERGENCY REPAIRS

A. The Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding the Contractor's guarantee bond nor relieving the Contractor of his responsibilities.

1.12 LOCATIONS

- A. Coordinate in advance of the work, requirements for openings, equipment maintenance clearances, recesses and chases in the walls, partitions, equipment housekeeping pads, framing or openings. Should furnishing this information be neglected, delayed or incorrect and additional cutting is found to be required, the cost of same shall be borne by the Contractor. Nothing in this paragraph shall be construed to relieve the Contractor of the responsibility for providing and paying for the required core drilling and openings in existing work.
- B. Diagrammatic Indications on Drawings are:
 - 1. Approximate only.
 - 2. At various locations shown distorted for clarity.
- C. Exact Locations Shall:
 - 1. Be as required for proper installation in available space.
 - 2. Avoid interference with architectural, electrical and structural features.

- 3. Be coordinated with the work of other trades toward the general purpose of having the work progress rapidly and smoothly with a minimum interference between one trade and another.
- 4. Preserve headroom and keep openings and passageways clear.
- 5. Have a neat arrangement symmetrical to the building lines, light and tile pattern.
- 6. Be reasonably accessible for hung ceiling areas for maintenance from the floor below. Equipment, valves, and other items requiring maintenance, adjustment and/or observation shall be accessible.
- 1.13 SUPPORTS, EQUIPMENT PADS, STAGING, ETC.
 - A. Construction supports required for the proper installation of equipment shall be in accordance with the drawings, manufacturer's requirements, seismic requirements, and applicable codes. Check architectural and structural drawings for equipment pads by others. Provide staging, scaffolds, platforms, ladders or similar facilities required to properly install the work.

1.14 INTERRUPTION OF UTILITIES

- A. The Contractor shall schedule and coordinate all interruptions of utilities with the Architect and Owner within 30 days after award of contract. The Contractor shall submit to the Owner a schedule of proposed interruptions. At least 72 hours prior to the interruption, the contractor shall submit a request indicating the proposed date and duration of interruption, the work to be accomplished, the areas which will be affected and a proposed contingency plan to be followed in the event that normal service or facilities cannot be restored on schedule. Do not commence work until the time, date, and contingency have been approved in writing by the Architect and Owner.
- B. Provide any labor and materials necessary to restore services on a contingency basis should normal service or facilities not be restored on schedule.
- C. Preparatory work associated with each interruption shall be performed during normal work hours. The actual interruption required for tie-in shall be performed between 8 P.M. and 5 A.M. Maximum shutdown during this period of any system shall be 4 hours.

1.15 SUBSTITUTIONS

- A. If substitutions of controls or equipment requires any changes in the architectural, structural, mechanical, plumbing or electrical work from that shown on the drawings (including all environmental characteristics), the extra cost of the equipment or architectural, structural, mechanical, plumbing or electrical work shall be responsibility of the Contractor requesting the substitution. All substitutions shall be approved by the Architect before purchase by the contractor.
- B. If the Contractor proposes substitutions of any equipment specified herein or on the drawings, it shall be the Contractor's responsibility to obtain approval from the Architect for such equipment as well as approval for anchorage of such equipment from the Architect, Structural Engineer, and governing approval agencies (Department of the State Architects DSA). All costs required for such approval shall be the responsibility of the Contractor requesting the substitution.

1.16 PREPARATION OF SUBMITTALS

- A. Refer to Division 1. In addition to the requirements of Division 1, provide the requirements specified herein.
- B. Prior to commencement of work and in accordance with the General Requirements, submit for review six copies of proposed equipment and material submittals. The Contractor shall verify the delivery dates are compatible with the specified construction schedule; and verify the equipment is sized to accommodate the conditions specified. Submittals shall include manufacturer's names and model numbers and shall comply with specifications and drawings. The Contractor shall bear the cost of changes necessary to accommodate substitutions if substitution is approved.
- C. Provide formal submittal to Architect. Review of the formal submittal is only for general conformance with design concept of project and general compliance with the information given in the contract documents. The Contractor is responsible for confirmation and correlation of the dimensions, quantities and sizes, for information that pertains to fabrication methods or construction techniques, and for coordination of work of all trades. Deviations from Drawings and Specifications shall be clearly and completely indicated (by a separate letter) in the formal submittals. Reviewed Submittals shall not relieve the Contractor of responsibility for errors or deviations.
 - 1. Where specific model numbers and/or manufacturers are specified or shown, it is the intent of the contract documents to procure the specified item(s). Alternate equipment may not be used unless data is submitted for consideration as a substitution in accordance with General Requirements and this section.
 - 2. Model numbers used may not indicate all features or options required for this specific installation. Modify the specified models to comply with the requirements, as specified or shown.
 - 3. Product Data for Proposed Substitutions:
 - a. Submit copies of complete data, with drawings and samples as appropriate, including:
 - 1) Comparison of the qualities of the proposed substitution with that specified.
 - 2) Changes required in other elements of the work because of the substitution.
 - 3) Effect on construction schedule.
 - 4) Cost data comparing the proposed substitution with the product specified.
 - 5) Availability of maintenance service and source of replacement materials.
 - 6) Reference to three (3) projects similar to this where such equipment is installed and operating to two (2) or more years.
 - b. Acceptance of substitutions is entirely at the discretion of the Architect.
- D. Formal submittals shall be complete with catalog data and information properly marked to indicate equality of material (where substitution is allowed and desired), adequacy in capacity and performance to meet minimum capacities or performance as specified or

indicated. Arrange the submittals in the same sequence as these Specifications and indicate the Section and Paragraph number (in the upper right-hand side with tabs) for which each submittal is intended. Incomplete submittals shall be rejected.

- E. Do not fabricate order or deliver materials or equipment until formal submittals have been approved. Where material or equipment is used without such permission, it is deemed that the material or equipment shall be in complete compliance with drawings and specifications, without additional cost where such compliance is lacking and may be required to be altered in the field.
- F. Submittals shall be bound and shall include, at a minimum, the following:
 - 1. Complete bill of materials listing equipment furnished.
 - 2. Catalog cut sheets of every component being provided (highlighted).
 - 3. Provide completed blue-line shop drawings of the packaged equipment detailing all field connection points.
 - 4. Dimensions, clearance requirements, weights, and capacities.
 - 5. Wiring diagrams showing control interface as applicable.
 - 6. Warranty sheets.
 - 7. Pressure drops as applicable.
- G. Contractor shall incur all costs for time spent by Engineer for review of more than two submittals on each item. Costs shall be based on Engineer's hourly billing rate schedule at the time of review. Rate schedule available upon request. Engineer shall invoice the contractor upon completion of review and shall be paid by the contractor within 30 days of date of invoice. Failure to remit will withdraw approval (if any) of submittals in question.

1.17 SHOP DRAWINGS:

- A. Proceed with preparation of shop drawings immediately upon receiving an authorization to proceed for the project. Shop drawings shall be originally prepared by the contractor. Provide minimum 1/4" scale shop drawings in electronic format. Submit a complete set in one package prior to material fabrication, order and installation.
- B. Include:
 - 1. Duct and pipe elevations and sizes.
 - 2. Double line ductwork and piping.
 - 3. Actual size of owner furnished, and contractor purchased equipment from certified shop drawings.
 - 4. Access panels.
 - 5. Access clearances for equipment.
 - 6. Actual locations of supply registers.
 - 7. Actual locations of manual volume dampers.
 - 8. Locations of structural penetrations such as walls, columns and beams (where approved by structural engineer).
 - 9. Actual location of control panels and power connections to equipment.
 - 10. Label and tag schedule for equipment.
 - 11. Duct transitions to clear beams or tight areas.

- 12. Room temperature sensor locations.
- 13. Point of connection to utilities outside the building.
- 14. Sections or 3-dimensional drawings of congested areas.
- 15. Gridlines.
- 16. Duct and piping supports on walls, pedestals and frames.
- C. Coordinate with other trades in preparation of shop drawings.
- D. Submit a copy of coordinated shop drawings to General Contractor for distribution to other trades, including electrical and fire sprinkler contractor.
- E. Submit to Architect for approval to assure design intent is met.
- F. Prior to fabrication, submit a complete set of shop drawings at one time to the Architect for final review.
- 1.18 ELECTRICAL REQUIREMENTS
 - A. Coordinate the following items with Division 26:
 - 1. Power wiring
 - 2. Power Supply Voltage Requirements
 - 3. Safety switches
 - 4. Combination controllers
 - 5. Disconnect switches
 - 6. Motor starters
 - 7. Circuit breakers
 - 8. Motor-control equipment forming part of motor control centers or switchgear assemblies
 - 9. Electrical connections of the mechanical equipment to the electrical power source shall be coordinated with and provided under Division 26.

1.19 MOTORS

A. Before order is placed for electrical devices, the Contractor shall check with the Electrical contractor and verify requirements as to type, mounting and current characteristics as well as to any special delivery instructions. Motors provided under Division 23 shall be minimum of 10% normal rating above brake horsepower (BHP) rating of equipment driven.

1.20 TESTS

- A. Contractor shall make tests required by legally constituted authorities and as listed below.
 - 1. Tests shall be made in the presence of the Owner or his representative and a duly authorized inspector. The Owner or his representative shall be notified 5 days before tests are made.
 - 2. Concealed work and insulated work shall remain uncovered until required testing has been performed and approved by the Owner. If work to be tested is covered

before the approval of the Owner or his authorized representative has been obtained, it shall be uncovered for testing at the Contractor's expense.

- 3. Obtain required documents of certification indicating approval, acceptance and compliance with the requirements of all administrative authorities having jurisdiction over the work. No final payment shall be made until all such certificates are delivered to the Owner.
- 4. Furnish labor, materials, instruments and bear other costs in connection with all tests.
- 5. Piping systems, except as hereinafter noted, shall be given hydrostatic (with water) test of a least 150% of the maximum system operating pressure but no less than 100 psig.
- 6. Before making test, remove or valve off from the system, gauges, traps, and other apparatus or equipment which may be damaged by test pressure.
- 7. Install a calibrated test pressure gauge in the system to observe any loss in pressure. Maintain the required test pressure for a sufficient length of time to enable an inspection to be made of all joints and connections. Perform tests after installation and prior to acceptance.
- 8. Final pressures at the end of the test period shall be no more or less than that caused by expansion or contraction of the test medium due to temperature changes.
- 9. After tests have been made and leaks repaired, clean and flush systems as hereinafter specified. Water piping shall be left under supply main pressure for the balance of the construction period.
- 10. Tests for mechanical, refrigerant piping, plumbing systems are specified within their own section. Equipment and ductwork system tests are specified in the test and balance section.
- 11. Provide necessary provisions and tests for maintaining the operational condition and cleanliness of existing systems.

1.21 LABOR AND MATERIALS

- A. Labor shall be carefully skilled for this kind of work, and under the direction of a competent foreman.
- B. Materials shall be new, in perfect condition and of domestic manufacturer. Materials for similar uses to be of same type and manufacturer.
- C. Equipment shall bear the manufacturer's label showing performance characteristics. Identifying size number shall be given only when it is not practicable or customary to show performance characteristics.
- D. Valves, pipe, fittings, etc., shall bear the manufacturer's name or trademark.
- E. Unless otherwise specified herein, equipment and fixtures shall be installed in accordance with the manufacturer's recommendations, including recommended service and removal clearances.

1.22 PROTECTION AND CLEAN-UP

A. Protection: Provide for the safety and good condition of materials and equipment until final acceptance of the Architect. Protect materials and equipment from dirt, dust,

debris, and damage from any cause whatever, and provide adequate and proper storage facilities during the progress of the work and replace all damaged and defective material, equipment or work precedent to filing application for final acceptance.

- B. Cleaning:
 - 1. Unless a more stringent requirement is specified, thoroughly clean all parts of the piping, ductwork, fixtures, apparatus and equipment. All parts shall be thoroughly cleaned of dirt, dust, debris, cement, plaster and other materials, and all grease and oil spots removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Clean all systems, including piping and ductwork prior to test.
 - 2. Exposed rough metal work shall be carefully brushed down with steel brushes to remove rust and other spots and left in clean condition to receive painter's finish. Where factory prime coat has been damaged, this Contractor shall be responsible for restoration of same.

1.23 ACCESS PANELS

- A. Access Doors and Panels:
 - 1. Wherever volume dampers, fire dampers, smoke fire dampers, controls, valves or other items or parts of the installation which require periodic inspection or adjustments are concealed by permanent non-removable construction, an access door shall be provided. Rating of access panel shall be determined by rating of wall or ceiling in which panel is installed. Types to be as approved and as appropriate for the surface and construction in which it is installed. Verify all locations with Architect and other trades.
 - 2. Access doors and panels shall be of sufficient size and shall be located properly to assure service to the intended item.

1.24 MAINTENANCE, OPERATION INSTRUCTION

- A. General: Thoroughly instruct the Owner's operators in every detail of operation of the system. Provide the Owner with a list of all equipment, giving the manufacturer's name, model number, serial number, parts list and complete internal wiring diagrams. All directions for operation furnished by the manufacturer shall be carefully saved and turned over to the Owner, together with written sequence of operation, operating and maintenance instructions for each system and its equipment. Instruction shall consist of a minimum of four 8-hour periods over consecutive days and shall be 30% classroom and 70% at site location. Coordinate scheduling of instruction times with Owner's operators.
- B. Specific Data: Submit four complete sets of the following data to the Owner for approval and commissioning agent for review prior to acceptance of the installation, complete and at one time; (partial or separate data will not be accepted) data shall consist of the following:
 - 1. Valve Directory: Indicating valve number, location, function and normal operating position for each.

- 2. Color code schedule.
- 3. Equipment: List of name plates, including name plate data.
- 4. Manufacturer's Literature: Copies of manufacturer's instructions for operation and maintenance of all mechanical equipment, including replacement parts lists and drawings. Mark or highlight brochure literature indicating the models, sizes, capacities, curve operating points, etc., in a manner to clearly indicate the equipment installed. Remove all pages or sheets from the bulletin and catalogs that do not pertain to equipment installed on the project.
- 5. Written Instructions: Typewritten instructions for operation and maintenance of the system composed of OPERATING INSTRUCTIONS, MAINTENANCE INSTRUCTIONS and a MAINTENANCE SCHEDULE.
 - a. OPERATING INSTRUCTIONS shall contain a brief description of the system. Adjustments requiring the technical knowledge of the service agency personnel shall not be included in the operating instructions. The fact such adjustments are required, however, shall be noted.
 - b. MAINTENANCE INSTRUCTIONS shall list each item of equipment requiring inspection, lubrication or service and describe the performance of such maintenance.
 - c. MAINTENANCE SCHEDULE shall list each item of equipment requiring maintenance, shall show the exact type of maintenance on every component of each item of equipment, and shall show when each item of equipment should be inspected or services.
- 6. Instructions: Operating personnel shall be instructed in the operation of the system in accordance with typewritten, approved instructions.
- C. Binders: Provide complete sets of the above data in loose-leaf ring-type binders with permanent covers, with identification on front and on spine.

1.25 SPECIAL REQUIREMENTS

- A. During the guarantee period and as directed by the Owner, make any additional tests, adjustment, etc., that may be required and correct any defects or deficiencies arising from operation of the systems. Operational tests shall be made during both heating and cooling seasons and on all systems.
- B. Completion:
 - 1. The entire mechanical system shall be commissioned in accordance with ASHRAE Guideline 1-1996 and the requirements of this specification. A final commissioning report shall be approved by the Owner, Architect, and Mechanical Engineer prior to final acceptance of the work.
 - 2. When the installation is complete and adjustments specified herein have been made, the system, shall be operated for a period of one week, during which time it shall be demonstrated to the Owner or his representative as being completed and operating in conformance with these specifications. The Contractor shall schedule all work so that this time period, which is to confirm a "bug-free" system, will occur before the total project is accepted for substantial completion by Owner.

3. The work hereunder shall not be reviewed for final acceptance until operating and maintenance data, manufacturer's literature, valve directories, piping identification code directory, and nameplates specified herein have been approved and properly posted in the building.

1.26 WARRANTY/GUARANTEE

- A. The contractor shall warranty/guarantee that materials, apparatus, and equipment furnished and installed under the mechanical division of these specifications shall be new and free from all defects. Should any defects develop, within one year (unless a longer period is listed in other sections of the specifications) from the date of final acceptance by the owner or from the date of certificate of substantial completion, whichever is earlier, due to inferior or faulty materials and/or workmanship, the trouble shall be corrected by this Contractor without expense to the Owner. Any defective materials or inferior workmanship noticed at the time of installation or during the guarantee period shall be corrected immediately to the entire satisfaction of the Owner.
- B. The work shall be installed of such materials and in such a manner that:
 - 1. The operation of all parts of the system shall be noiseless to the extent that no objectionable sound of operation will be heard outside of the rooms enclosing the apparatus or equipment.
 - 2. Apparatus or equipment shall operate in accordance with detailed specifications covering each item.
 - 3. Contractor shall, at his own expense, make any adjustments or changes required to produce a condition of quietness satisfactory to the Engineer or his representative. Such adjustments or changes shall not reduce the performance or quantities called for on the drawings.
 - 4. Contractor shall guarantee that his installation of all materials and equipment will meet the performance requirements of these specifications and that all equipment will deliver the specified or required capacities.
 - 5. The Owner reserves the right to make temporary or emergency repairs as necessary to keep equipment in operating condition without voiding the guarantee contained herein nor relieving the Contractor of his responsibilities during the guarantee period.
 - 6. Contractor shall be responsible for all damage to any part of the premises caused by leaks or break in pipe lines, fixtures or equipment furnished and installed under his contract for a period of one year after date of acceptance of the project by Owner. He shall replace in kind, at his own expense, any and all items so damaged to the complete satisfaction of the Owner.

END OF SECTION

SECTION 23 00 50

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Concrete base construction requirements.
 - 3. Escutcheons.
 - 4. Dielectric fittings.
 - 5. Flexible connectors.
 - 6. Mechanical sleeve seals.
 - 7. Equipment nameplate data requirements.
 - 8. Labeling and identifying mechanical systems and equipment is specified in Division 23 Section "Identification for HVAC Piping and Equipment."
 - 9. Nonshrink grout for equipment installations.
 - 10. Field-fabricated metal and wood equipment supports.
 - 11. Installation requirements common to equipment specification sections.
 - 12. Cutting and patching.
 - 13. Touchup painting and finishing.
- B. Pipe and pipe fitting materials are specified in Division 23 piping system Sections.
- C. Related Sections include the following:
 - 1. Division 00 and 01: Procurement and Contracting Requirements and General Requirements
 - 2. Division 22: Plumbing.
 - 3. Division 26: Electrical
- 1.03 DEFINITIONS
 - A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
 - B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for rubber materials:
 - 1. CR: Chlorosulfonated polyethylene synthetic rubber.
 - 2. EPDM: Ethylene propylene diene terpolymer rubber.

1.04 SUBMITTALS

- A. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.
- B. LEED Submittals: Provide cost data breakdown, recycle content and manufacturer name and location.
- C. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
- D. Coordination Drawings: For access panel and door locations.
- E. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 - 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 - 2. Clearances for installing and maintaining insulation.
 - 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - 4. Equipment and accessory service connections and support details.
 - 5. Exterior wall and foundation penetrations.
 - 6. Fire-rated wall and floor penetrations.
 - 7. Sizes and location of required concrete pads and bases.
 - 8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 - 9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 - 10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

F. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.

1.05 QUALITY ASSURANCE

A. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.06 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 prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- 1.07 SEQUENCING AND SCHEDULING
 - A. Coordinate mechanical equipment installation with other building components.
 - B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
 - C. Coordinate installation of required supporting devices and set sleeves in poured-inplace concrete and other structural components, as they are constructed.
 - D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
 - E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
 - F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section.

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Dielectric Unions:
 - a. Epco Sales Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Industries, Inc.; Wilkins Div.
 - 2. Dielectric Flanges:
 - a. Epco Sales Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - 3. Dielectric-Flange Insulating Kits:
 - a. Calpico, Inc.
 - b. Central Plastics Co.
 - 4. Dielectric Couplings:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
 - 5. Dielectric Nipples:
 - a. Grinnell Corp.; Grinnell Supply Sales Co.
 - b. Victaulic Co. of America.
 - 6. Mechanical Sleeve Seals:
 - a. Calpico, Inc.
 - b. Metraflex Co.
 - c. Thunderline/Link-Seal.

2.02 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

- A. Refer to individual Division 23 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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32.
 - 1. Alloy E: Approximately 95 percent tin and 5 percent antimony, lead free.
- F. Brazing Filler Metals: AWS A5.8.
 - 1. BCuP Series: Copper-phosphorus alloys.
 - 2. BAg1: Silver alloy.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.
- I. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
 - 1. Sleeve: ASTM A 126, Class B, gray iron.
 - 2. Followers: ASTM A 47 malleable iron or ASTM A 536 ductile iron.
 - 3. Gaskets: Rubber.
 - 4. Bolts and Nuts: AWWA C111.
 - 5. Finish: Enamel paint.

2.04 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

- B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300psig minimum working pressure as required to suit system pressures.
- F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, fullface or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Provide separate companion flanges and steel bolts and nuts for 150- or 300psig minimum working pressure as required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
- 2.05 MECHANICAL SLEEVE SEALS
 - A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.
- 2.06 PIPING SPECIALTIES
 - A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
 - 1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
 - 2. Steel Pipe: ASTM A 53, Type É, Grade A, Schedule 40, galvanized, plain ends.
 - 3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
 - 4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with setscrews.
 - 5. PE: Manufactured, reusable, tapered, cup shaped, smooth outer surface, with nailing flange for attaching to wooden forms.
 - B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
 - 1. ID: Closely fit around pipe, tube, and insulation of insulated piping.

- 2. OD: Completely cover opening.
- 3. Cast Brass: Split casting, with concealed hinge and set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.
- 4. Stamped Steel: One piece, with spring clips and chrome-plated finish.
- 5. Stamped Steel: Split plate, with concealed hinge, spring clips, and chromeplated finish.
- 6. Cast-Iron Floor Plate: One-piece casting.
- 2.07 GROUT
 - A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
 - 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psig, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

- 3.01 PIPING SYSTEMS COMMON REQUIREMENTS
 - A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 23 piping Sections specify unique piping installation requirements.
 - B. General Locations and Arrangements: 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 at indicated slope.
 - D. Install components with pressure rating equal to or greater than system operating pressure.
 - E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
 - F. Install piping free of sags and bends.
 - G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
 - H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

- I. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- K. Install fittings for changes in direction and branch connections.
- L. Install couplings according to manufacturer's written instructions.
- M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
 - 1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish.
 - 2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
 - 3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
 - 4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
 - 5. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- N. Sleeves are not required for core drilled holes.
- O. Permanent sleeves are not required for holes formed by PE removable sleeves.
- P. 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 castiron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Build sleeves into walls and slabs as work progresses.
 - 3. Install sleeves 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 6-inch NPS.
 - b. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Sections for flashing.
 - 1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.

- 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 7 Sections for materials.
- 5. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
- Q. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve 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 in diameter and larger.
 - 3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- R. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Division 7 Sections for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- V. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
 - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - 3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
 - 4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 5. 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:
 - a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

- b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
- c. Align threads at point of assembly.
- d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
- e. 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.
- 6. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
- 7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- W. Piping Connections: Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
 - 2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
 - 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.
- 3.02 EQUIPMENT INSTALLATION COMMON REQUIREMENTS
 - A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
 - B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
 - C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
 - D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
 - E. Install equipment giving right of way to piping installed at required slope.

- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.
- 3.03 PAINTING AND FINISHING
 - A. Refer to Division 9 Section "Painting" for paint materials, surface preparation, and application of paint.
 - B. Apply paint to exposed piping according to the following, unless otherwise indicated:
 - 1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 - 3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
 - 5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 - 6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
 - C. Paint visible sheet metal behind ceiling inlets and outlets flat black.
 - D. Do not paint piping specialties with factory-applied finish.
 - E. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psig, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.05 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."
- 3.06 ERECTION OF WOOD SUPPORTS AND ANCHORAGE
 - A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.
- 3.07 CUTTING AND PATCHING
 - A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
 - B. Repair cut surfaces to match adjacent surfaces.

3.08 GROUTING

- A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's written instructions.

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes general requirements for single-phase and polyphase, generalpurpose, 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.

1.03 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

- 2.01 GENERAL MOTOR REQUIREMENTS
 - A. Comply with NEMA MG 1 unless otherwise indicated.
 - B. Comply with IEEE 841 for severe-duty motors.
- 2.02 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.
- 2.03 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. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. 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.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- 2.04 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. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.
- 2.05 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)

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.03 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 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 (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.02 STACK-SLEEVE FITTINGS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.03 SLEEVE-SEAL SYSTEMS

- 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:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product 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.
- C. 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: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.04 SLEEVE-SEAL FITTINGS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Presealed Systems.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

- 2.05 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 (34.5-MPa), 28-day compressive strength.
 - D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 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 (25-mm) annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeveseal 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 (6.4-mm) 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. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.02 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."
- 3.03 SLEEVE-SEAL-SYSTEM INSTALLATION
 - A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
 - B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.
- 3.04 SLEEVE-SEAL-FITTING INSTALLATION
 - A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
 - B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
 - C. Secure nailing flanges to concrete forms.
 - D. Using grout, seal the space around outside of sleeve-seal fittings.
- 3.05 SLEEVE AND SLEEVE-SEAL SCHEDULE
 - A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves Galvanizedsteel wall sleeves Galvanized-steel-pipe sleeves Sleeve-seal fittings.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves.

- 2. Interior Partitions:
 - Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves. a.
 - b.

ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.
- 1.03 ACTION SUBMITTALS
 - A. Product Data: For each type of product indicated.
- PART 2 PRODUCTS
- 2.01 ESCUTCHEONS
 - A. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
 - B. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.
- 2.02 FLOOR PLATES
 - A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
 - B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

- 3.01 INSTALLATION
 - A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
 - B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deeppattern type.
- b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- c. Insulated Piping: One-piece, stamped-steel type or split-plate, stampedsteel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
- d. Bare Piping at Ceiling Penetrations in Finished Spaces: Two-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
- e. Bare Piping in Equipment Rooms: Caulk annular space.
- C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: Two-piece, floor-plate type.
- 3.02 FIELD QUALITY CONTROL
 - A. Replace broken and damaged escutcheons and floor plates using new materials.

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 00 and 01: Procurement and Contracting Requirements and General Requirements
 - 2. Division 22: Plumbing.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Test plugs.
- 1.03 ACTION SUBMITTALS
 - A. Product Data: For each type of product indicated.
 - B. Wiring Diagrams: For power, signal, and control wiring.
- 1.04 INFORMATIONAL SUBMITTALS
 - A. Product Certificates: For each type of meter and gage, from manufacturer.
- 1.05 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.
- PART 2 PRODUCTS
- 2.01 TEST PLUGS
 - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flow Design, Inc.
 - 2. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 3. 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 1/4 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.

PART 3 - EXECUTION

- 3.01 INSTALLATION
 - A. Install test plugs in piping tees.

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Bronze ball valves.
 - 3. Iron ball valves.
 - 4. Iron, single-flange butterfly valves.
 - 5. Bronze lift check valves.
 - 6. Bronze swing check valves.
 - 7. Iron swing check valves.
 - 8. Iron swing check valves with closure control.
 - 9. Iron, grooved-end swing-check valves.
 - 10. Iron, center-guided check valves.
 - 11. Iron, plate-type check valves.
 - 12. Bronze gate valves.
- B. Related Sections:
 - 1. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.
- 1.03 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.

1.04 SUBMITTALS

- A. Product Data: For each type of valve indicated.
- 1.05 QUALITY ASSURANCE
 - A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
 - B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.
- 1.06 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

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.

- 2. Handwheel: For valves other than quarter-turn types.
- 3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
- 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.
- 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 2. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.
- 2.02 BRASS BALL VALVES
 - A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - 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. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Milwaukee Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

2.03 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Milwaukee Valve Company.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- 2.04 IRON BALL VALVES
 - A. Class 125, Iron Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-72.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Split body.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Ends: Flanged.
 - f. Seats: PTFE or TFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel.
 - i. Port: Full.

2.05 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Red-White Valve Corporation.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig (1035 kPa).
 - 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.

2.06 IRON, GROOVED-END BUTTERFLY VALVES

- A. 175 CWP, Iron, Grooved-End Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Shurjoint Piping Products.
 - b. Tyco Fire Products LP; Grinnell Mechanical Products.
 - c. Victaulic Company.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 175 psig (1200 kPa).
 - c. Body Material: Coated, ductile iron.
 - d. Stem: Two-piece stainless steel.
 - e. Disc: Coated, ductile iron.
 - f. Seal: EPDM.

2.07 BRONZE LIFT CHECK VALVES

- A. Class 125, Lift Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - 2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Vertical flow.
- d. Body Material: ASTM B 61 or ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.
- B. Class 125, Lift Check Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mueller Steam Specialty; a division of SPX Corporation.
 - b. Red-White Valve Corporation.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: NBR, PTFE, or TFE.
- 2.08 BRONZE SWING CHECK VALVES
 - A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Stockham Division.
 - b. Milwaukee Valve Company.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig (1380 kPa).
 - 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 available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Crane Co.; Crane Valve Group; Stockham Division.
- b. Milwaukee Valve Company.
- c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.

2.09 IRON SWING CHECK VALVES

- A. Class 125, Iron Swing Check Valves with Metal Seats:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
- B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Composition.

- g. Seat Ring: Bronze.
- h. Disc Holder: Bronze.
- i. Disc: PTFE or TFE.
- j. Gasket: Asbestos free.

2.10 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Metraflex, Inc.
 - b. Mueller Steam Specialty; a division of SPX Corporation.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer.
 - e. Seat: Bronze.
- B. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Metraflex, Inc.
 - b. Mueller Steam Specialty; a division of SPX Corporation.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: Bronze.
- C. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Milwaukee Valve Company.

- c. NIBCO INC.
- d. Spence Strainers International; a division of CIRCOR International.
- e. Sure Flow Equipment Inc.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer.
 - e. Seat: EPDM.
- D. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: EPDM or NBR.
- 2.11 IRON, PLATE-TYPE CHECK VALVES
 - A. Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Inc.
 - b. Sure Flow Equipment Inc.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Wafer, spring-loaded plate.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Seat: EPDM or NBR.

- B. Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Stockham Division.
 - b. Spence Strainers International; a division of CIRCOR International.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: API 594.
 - NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Wafer, spring-loaded plates.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Seat: EPDM or NBR.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service except Steam: Ball valves.
 - 4. Pump-Discharge Check Valves:
 - a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 (DN 65) and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check 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 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
 - 7. For Grooved-End Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

3.05 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2 (DN 50) and Smaller:
 - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two piece, full port, brass or bronze with bronze trim.
 - 3. Bronze Swing Check Valves: Class 125, nonmetallic disc.

- B. Pipe NPS 2-1/2 (DN 65) and Larger:
 - 1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
 - 2. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
 - 3. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM seat, aluminum-bronze disc.
 - 4. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
 - 5. Iron, Center-Guided Check Valves: Class 125, compact-wafer, resilient seat.
 - 6. Iron, Plate-Type Check Valves: Class 125; single plate; resilient seat.

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Refer to DSA anchorage notes on sheet M0.01.

1.02 SUMMARY

- A. This Section includes the following hangers and supports for mechanical system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
 - 3. Division 23 Section "Metal Ducts" for duct hangers and supports.

1.03 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."
- 1.04 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 within limits and under conditions indicated according to ASCE/SEI 7 & 1615A.1.21 of CBC.
 - 1. Design supports for multiple pipes, including pipe stands, 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.

1.05 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Powder-actuated fastener systems.
 - 4. Pipe positioning systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Pipe stands. Include Product Data for components.
 - 4. Equipment supports.
- C. 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. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.
- D. Welding Certificates.
- 1.06 QUALITY ASSURANCE
 - A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel.".
 - B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- 2.02 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. Grinnell Corp.
 - 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.
- 2.03 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 Ubolts.
- 2.04 METAL FRAMING SYSTEMS
 - A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
 - B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Power-Strut Div.; Tyco International, Ltd.
 - 3. Unistrut Corp.; Tyco International, Ltd.
 - 4. Tolco, Inc.
 - C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 - D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.05 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. ERICO/Michigan Hanger Co.
 - 2. Pipe Shields, Inc.
 - 3. Rilco Manufacturing Company, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- 2.06 FASTENER SYSTEMS
 - A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Masterset Fastening Systems, Inc.
 - B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.

2.07 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

- 3.01 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, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 5. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 - 6. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 7. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or 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. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - 5. 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.
 - 6. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 - 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 - 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

- 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
- 6. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
- 7. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.
- 3.02 HANGER AND SUPPORT INSTALLATION
 - A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
 - B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
 - C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
 - D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
 - E. Fastener System Installation:

- 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. 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.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. 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.
- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- M. 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 B31.1 for power piping and 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 weightdistribution 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 weightdistribution 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.
- 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.
- 3.03 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.
- 3.04 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.

3.05 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.

3.06 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.

VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to DSA anchorage notes on sheet M0.01.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Elastomeric isolation mounts.
 - 2. Housed-restrained-spring isolators.
 - 3. Spring hangers.
 - 4. Snubbers.
 - 5. Restraint cables.
 - 6. Seismic-restraint accessories.
 - 7. Mechanical anchor bolts.
 - 8. Adhesive anchor bolts.
 - B. Related Requirements:
 - 1. Section 22 05 48 "Vibration and Seismic Controls for Plumbing" for devices for plumbing equipment and systems.
- 1.03 DEFINITIONS
 - A. IBC: International Building Code.
 - B. ICC-ES: ICC-Evaluation Service.
 - C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).
- 1.04 ACTION SUBMITTALS
 - A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.

- a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
- b. Annotate to indicate application of each product submitted and compliance with requirements.
- 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
 - 1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic forces required to select vibration isolators and seismic and wind restraints and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - 3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
 - 4. Seismic Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with windrestraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer.
- C. Welding certificates.
- D. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number 0349 & 0198 from OSHPD, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: A.
 - 2. Assigned Seismic Use Group or Building Category as Defined under Structural specifications.
 - a. Component Importance Factor: 1.0.
 - b. Component Response Modification Factor: 1.5.
 - c. Component Amplification Factor: 1.0.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second).
 - 4. Design Spectral Response Acceleration at 1.0-Second Period.
 - 5. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
a. 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 are subjected.

2.02 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Vibration Isolation.
 - 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 - 3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.03 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.
 - 2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.04 SPRING HANGERS

Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Mason Industries, Inc.
 - b. Vibration Eliminator Co., Inc.
 - c. Vibration Isolation.
- 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
- 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washerreinforced cup to support spring and bushing projecting through bottom of frame.
- 8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
- 9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.05 SNUBBERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Insert manufacturer's name; product name or designation or comparable product by one of the following:
 - 1. Kinetics Noise Control, Inc.
 - 2. Mason Industries, Inc.
 - 3. Vibration Mountings & Controls, Inc.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 - 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and studwedge or female-wedge type.
 - 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 - 3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

2.06 RESTRAINT CHANNEL BRACINGS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hilti, Inc.
 - 3. Mason Industries, Inc.
 - 4. Unistrut.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.07 RESTRAINT CABLES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Kinetics Noise Control, Inc.
 - 2. Loos & Co., Inc.
 - 3. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.08 SEISMIC-RESTRAINT ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Mason Industries, Inc.
 - 3. TOLCO.
- B. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.09 MECHANICAL ANCHOR BOLTS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hilti, Inc.
 - 3. Kinetics Noise Control, Inc.
 - 4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinccoated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.
- 2.10 ADHESIVE ANCHOR BOLTS
 - A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Hilti, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
 - B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- B. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete." or Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Section 07 72 00 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- D. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- H. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer 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. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 23 21 13 "Hydronic Piping" for piping flexible connections.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. Test and adjust restrained-air-spring isolator controls and safeties.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.
- 3.06 ADJUSTING
 - A. Adjust isolators after piping system is at operating weight.
 - B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Warning tags.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.04 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

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White

- 3. Background Color: Black
- 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 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.
- 7. Fasteners: Stainless-steel self-tapping screws.
- 8. 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-11inch 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.

2.02 WARNING SIGNS AND 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: Yellow
- 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 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.

PART 3 - EXECUTION

3.01 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.
- 3.02 EQUIPMENT LABEL INSTALLATION
 - A. Install or permanently fasten labels on each major item of mechanical equipment.
 - B. Locate equipment labels where accessible and visible.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - c. Primary-secondary hydronic systems.
 - 3. Balancing steam systems.
 - 4. Testing, Adjusting, and Balancing Equipment:
 - a. Heat exchangers.
 - b. Motors.
 - c. Chillers.
 - d. Cooling towers.
 - e. Condensing units.
 - f. Boilers.
 - g. Heat-transfer coils.
 - 5. Testing, adjusting, and balancing existing systems and equipment.
 - 6. Sound tests.
 - 7. Vibration tests.
 - 8. Duct leakage tests.
 - 9. Control system verification.
- 1.03 DEFINITIONS
 - A. AABC: Associated Air Balance Council.
 - B. BAS: Building automation systems.

- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.
- 1.04 PREINSTALLATION MEETINGS
 - A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. 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.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.06 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC or NEBB
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABCor NEBB
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB or as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 "Air Balancing."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 "System Balancing."
- 1.07 FIELD CONDITIONS
 - A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
 - B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- PART 2 PRODUCTS (Not Applicable)

PART 3 - EXECUTION

- 3.01 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 installed systems for 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 applicable for intended purpose and are accessible.
 - C. Examine the approved submittals for HVAC systems and equipment.
 - D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.

- 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
 - 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning per the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."

- 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," and Section 23 07 19 "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.
- 3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS
 - A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check 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 23 31 13 "Metal Ducts."
- 3.05 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. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.

- c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
- d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
- 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the airhandling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
- 3. 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.
- 4. Obtain approval from commissioning authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
- 5. 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 occurs. 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.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.
 - 3. Adjust each inlet and outlet for specified airflow.
 - 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
 - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.
 - 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 - 4. Mark all final settings.
 - 5. Test system in economizer mode. Verify proper operation and adjust if necessary.

- 6. Measure and record all operating data.
- 7. Record final fan-performance data.

3.06 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Adjust the variable-air-volume systems as follows:
 - 1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
 - 2. Verify that the system is under static pressure control.
 - 3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point 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.
 - 4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. When in full cooling or full heating, ensure that there is no mixing of hotdeck and cold-deck airstreams unless so designed.
 - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
 - 5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

- 6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the airhandling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
- 7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
- 8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
- 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.07 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 - 1. Check liquid level in expansion tank.
 - 2. Check highest vent for adequate pressure.
 - 3. Check flow-control valves for proper position.
 - 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 - 5. Verify that motor starters are equipped with properly sized thermal protection.

6. Check that air has been purged from the system.

3.08 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
 - 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 - 2. Perform temperature tests after flows have been verified.

- E. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - 1. Measure and balance coils by either coil pressure drop or temperature method.
 - 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- F. Verify final system conditions as follows:
 - 1. Re-measure and confirm that total water flow is within design.
 - 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - 3. Mark final settings.
- G. Verify that memory stops have been set.
- 3.09 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.
 - B. Adjust the variable-flow hydronic system as follows:
 - 1. Verify that the differential-pressure sensor is located as indicated.
 - 2. Determine whether there is diversity in the system.
 - C. For systems with no diversity:
 - 1. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

- c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- 2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
- 3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
- 4. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
- 5. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- 6. Prior to verifying final system conditions, determine the system differentialpressure set point.
- 7. If the pump discharge valve was used to set total system flow with variablefrequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
- 8. Mark final settings and verify that all memory stops have been set.
- 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
- 10. Verify that memory stops have been set.
- D. For systems with diversity:

- 1. Determine diversity factor.
- 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
- 3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- 4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
- 5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
- 6. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure, and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.

- 7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- 8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
- 9. Prior to verifying final system conditions, determine system differential-pressure set point.
- 10. If the pump discharge valve was used to set total system flow with variablefrequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
- 11. Mark final settings and verify that memory stops have been set.
- 12. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
- 13. Verify that memory stops have been set.
- 3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS
 - A. Balance the primary circuit flow first.
 - B. Balance the secondary circuits after the primary circuits are complete.
 - C. Adjust pumps to deliver total design gpm.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.

- d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
- e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
- 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- D. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
- E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - 5. Perform temperature tests after flows have been balanced.
- F. For systems with pressure-independent valves at terminals:
 - 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 - 2. Perform temperature tests after flows have been verified.
- G. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - 1. Measure and balance coils by either coil pressure drop or temperature method.
 - 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- H. Verify final system conditions as follows:
 - 1. Re-measure and confirm that total water flow is within design.
 - 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - 3. Mark final settings.
- I. Verify that memory stops have been set.
- 3.11 PROCEDURES FOR STEAM SYSTEMS
 - A. Measure and record upstream and downstream pressure of each piece of equipment.

- B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
- C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- D. Check settings and operation of each safety valve. Record settings.
- E. Verify the operation of each steam trap.
- 3.12 PROCEDURES FOR MOTORS
 - A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
 - B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.
- 3.13 PROCEDURES FOR CONDENSING UNITS
 - A. Verify proper rotation of fans.
 - B. Measure entering- and leaving-air temperatures.
 - C. Record fan and motor operating data.
- 3.14 PROCEDURES FOR BOILERS
 - A. Hydronic Boilers:
 - 1. Measure and record entering- and leaving-water temperatures.
 - 2. Measure and record water flow.
 - 3. Record relief valve pressure setting.

3.15 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 for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
 - 4. Dry-bulb temperature of entering and leaving air.

- 5. Wet-bulb temperature of entering and leaving air for cooling coils.
- 6. Airflow.
- 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.
 - 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 steam coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Airflow.
 - 3. Inlet steam pressure.
- D. 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.
- 3.16 SOUND TESTS
 - A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at 15 locations as designated by the Architect.
 - B. Instrumentation:
 - 1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
 - 2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (LEQ).
 - 3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
 - 4. The accuracy of the sound-testing meter shall be plus or minus one decibel.
 - C. Test Procedures:
 - 1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
 - 2. Equipment should be operating at design values.
 - 3. Calibrate the sound-testing meter prior to taking measurements.
 - 4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.

- 5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
- 6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
- 7. Take readings no closer than 36 inches (900 mm) from a wall or from the operating equipment and approximately 60 inches (1500 mm) from the floor, with the meter held or mounted on a tripod.
- 8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.
- D. Reporting:
 - 1. Report shall record the following:
 - a. Location.
 - b. System tested.
 - c. dBA reading.
 - d. Sound pressure level in each octave band with equipment on and off.
 - 2. Plot sound pressure levels on NC worksheet with equipment on and off.

3.17 VIBRATION TESTS

- A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than 10.
- B. Instrumentation:
 - 1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
 - 2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
 - 3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
 - 4. Verify calibration date is current for vibration meter before taking readings.
- C. Test Procedures:
 - 1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
 - 2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.

- 3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
- 4. Record CPM or rpm.
- 5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.
- D. Reporting:
 - 1. Report shall record location and the system tested.
 - 2. Include horizontal-vertical-axial measurements for tests.
 - 3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
 - 4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.
- 3.18 DUCT LEAKAGE TESTS
 - A. Witness the duct pressure testing performed by Installer.
 - B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
 - C. Report deficiencies observed.
- 3.19 CONTROLS VERIFICATION
 - A. In conjunction with system balancing, perform the following:
 - 1. Verify temperature control system is operating within the design limitations.
 - 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 - 3. Verify that controllers are calibrated and function as intended.
 - 4. Verify that controller set points are as indicated.
 - 5. Verify the operation of lockout or interlock systems.
 - 6. Verify the operation of valve and damper actuators.
 - 7. Verify that controlled devices are properly installed and connected to correct controller.
 - 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 - 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
 - B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.
- 3.20 TOLERANCES
 - A. Set HVAC system's airflow 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
- Heating-Water Flow Rate: Plus or minus 10 percent 3.
- Cooling-Water Flow Rate: Plus or minus 10 percent 4.
- Β. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.21 PROGRESS REPORTING

- Initial Construction-Phase Report: Based on examination of the Contract Documents Α. 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.
- Status Reports: Prepare biweekly progress reports to describe completed procedures. Β. 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.

3.22 **FINAL REPORT**

- General: Prepare a certified written report; tabulate and divide the report into separate Α. 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.
 - Include a list of instruments used for procedures, along with proof of calibration. 2.
 - Certify validity and accuracy of field data. 3.
- Β. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - Fan curves. 2.
 - 3. Manufacturers' test data.
 - Field test reports prepared by system and equipment installers. 4.
 - Other information relative to equipment performance; do not include Shop 5. Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - Name and address of the TAB specialist. 2.
 - Project name. 3.
 - Project location. 4.
 - Architect's name and address. 5.
 - Engineer's name and address. 6.
 - 7. Contractor's name and address.

- 8. Report date.
- 9. Signature of TAB supervisor who certifies the report.
- 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
- 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
- 12. Nomenclature sheets for each item of equipment.
- 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
- 14. Notes to explain why certain final data in the body of reports vary from indicated values.
- 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Terminal units.
 - 6. Balancing stations.
 - 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches (mm), and bore.

- i. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
- j. Number, make, and size of belts.
- k. Number, type, and size of filters.
- 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Preheat-coil static-pressure differential in inches wg (Pa).
 - g. Cooling-coil static-pressure differential in inches wg (Pa).
 - h. Heating-coil static-pressure differential in inches wg (Pa).
 - i. Outdoor airflow in cfm (L/s).
 - j. Return airflow in cfm (L/s).
 - k. Outdoor-air damper position.
 - I. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
 - 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch (mm) o.c.
 - f. Make and model number.
 - g. Face area in sq. ft. (sq. m).
 - h. Tube size in NPS (DN).
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Average face velocity in fpm (m/s).
 - c. Air pressure drop in inches wg (Pa).

- d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
- e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
- f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
- g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
- h. Water flow rate in gpm (L/s).
- i. Water pressure differential in feet of head or psig (kPa).
- j. Entering-water temperature in deg F (deg C).
- k. Leaving-water temperature in deg F (deg C).
- I. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig (kPa).
- n. Refrigerant suction temperature in deg F (deg C).
- o. Inlet steam pressure in psig (kPa).
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h (kW).
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - I. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches (mm), and bore.
 - n. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 - 2. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Entering-air temperature in deg F (deg C).
 - c. Leaving-air temperature in deg F (deg C).
 - d. Air temperature differential in deg F (deg C).
 - e. Entering-air static pressure in inches wg (Pa).
 - f. Leaving-air static pressure in inches wg (Pa).
 - g. Air static-pressure differential in inches wg (Pa).
 - h. Low-fire fuel input in Btu/h (kW).
 - i. High-fire fuel input in Btu/h (kW).
 - j. Manifold pressure in psig (kPa).
 - k. High-temperature-limit setting in deg F (deg C).
 - I. Operating set point in Btu/h (kW).
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h (kW).

- H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h (kW).
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm (L/s).
 - i. Face area in sq. ft. (sq. m).
 - j. Minimum face velocity in fpm (m/s).
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h (kW).
 - b. Airflow rate in cfm (L/s).
 - c. Air velocity in fpm (m/s).
 - d. Entering-air temperature in deg F (deg C).
 - e. Leaving-air temperature in deg F (deg C).
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches (mm), and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - g. Number, make, and size of belts.

- 3. Test Data (Indicated and Actual Values):
 - Total airflow rate in cfm (L/s). a.
 - Total system static pressure in inches wg (Pa). b.
 - Fan rpm. C.
 - Discharge static pressure in inches wg (Pa). d.
 - e. Suction static pressure in inches wg (Pa).
- Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a J. grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - System and air-handling-unit number. a.
 - Location and zone. b.
 - Traverse air temperature in deg F (deg C). C.
 - Duct static pressure in inches wg (Pa). d.
 - Duct size in inches (mm). e.
 - f. Duct area in sq. ft. (sq. m).
 - Indicated airflow rate in cfm (L/s). g.
 - Indicated velocity in fpm (m/s). h.
 - i. Actual airflow rate in cfm (L/s).
 - Actual average velocity in fpm (m/s). j.
 - Barometric pressure in psig (Pa). k.
- K. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - System and air-handling unit identification. a.
 - Location and zone. b.
 - Apparatus used for test. C.
 - Area served. d.
 - Make. e.
 - f. Number from system diagram.
 - Type and model number. g.
 - h. Size.
 - Effective area in sq. ft. (sq. m). i i
 - 2. Test Data (Indicated and Actual Values):
 - Airflow rate in cfm (L/s). a.
 - b. Air velocity in fpm (m/s).
 - Preliminary airflow rate as needed in cfm (L/s). C.
 - Preliminary velocity as needed in fpm (m/s). d.
 - Final airflow rate in cfm (L/s). e.
 - Final velocity in fpm (m/s). f.
 - Space temperature in deg F (deg C). q.
- L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

- 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
- 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Entering-water temperature in deg F (deg C).
 - c. Leaving-water temperature in deg F (deg C).
 - d. Water pressure drop in feet of head or psig (kPa).
 - e. Entering-air temperature in deg F (deg C).
 - f. Leaving-air temperature in deg F (deg C).
- M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm (L/s).
 - g. Water pressure differential in feet of head or psig (kPa).
 - h. Required net positive suction head in feet of head or psig (kPa).
 - i. Pump rpm.
 - j. Impeller diameter in inches (mm).
 - k. Motor make and frame size.
 - I. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig (kPa).
 - b. Pump shutoff pressure in feet of head or psig (kPa).
 - c. Actual impeller size in inches (mm).
 - d. Full-open flow rate in gpm (L/s).
 - e. Full-open pressure in feet of head or psig (kPa).
 - f. Final discharge pressure in feet of head or psig (kPa).
 - g. Final suction pressure in feet of head or psig (kPa).
 - h. Final total pressure in feet of head or psig (kPa).
 - i. Final water flow rate in gpm (L/s).
 - j. Voltage at each connection.

- k. Amperage for each phase.
- N. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.23 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.
- B. Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- E. If TAB work fails, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
 - 3. If the second verification also fails, Architect may contact AABC Headquarters regarding the AABC National Performance Guaranty.
- F. Prepare test and inspection reports.
- 3.24 ADDITIONAL TESTS
 - A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 13

DUCT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes semirigid and flexible duct, and plenum, insulation; insulating cements; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
 - 1. Division 23 HVAC Pipe Insulation

1.03 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Removable insulation sections at access panels.
 - 2. Application of field-applied jackets.
 - 3. Applications at linkages for control devices.
- C. Surface-burning characteristics specified in "Quality Assurance" Article should be verified by an independent testing agency. Where critical, require test report Submittals. Delete test reports below if not required.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.
- E. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smokedeveloped rating of 50 or less.
- 1.05 DELIVERY, STORAGE, AND HANDLING
 - A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
- 1.06 COORDINATION
 - A. Coordinate clearance requirements with duct Installer for insulation application.
- 1.07 SCHEDULING
 - A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.
- PART 2 PRODUCTS
- 2.01 MANUFACTURERS
 - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mineral-Fiber Insulation:
 - a. CertainTeed Manson.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.

2.02 INSULATION MATERIALS

- A. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
- 2.03 ACCESSORIES AND ATTACHMENTS
 - A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8-oz./sq. yd.
 - 1. Tape Width: 4 inches.
 - B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

- 1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
- 2. Galvanized Steel: 0.005 inch thick.
- 3. Nickel-Copper Alloy: 0.005 inch thick.
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.
- D. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
 - 1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts and plenums; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.

2.04 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

- 3.01 EXAMINATION
 - A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - B. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.02 PREPARATION
 - A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

- F. Keep insulation materials dry during application and finishing.
- G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Apply insulation with the least number of joints practical.
- I. Apply insulation over fittings and specialties, with continuous thermal and vaporretarder integrity, unless otherwise indicated.
- J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- L. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
 - 3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.
 - 1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
 - 2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.
- O. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - 3. Seal insulation to roof flashing with vapor-retarder mastic.
- P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

Q. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

3.04 MINERAL-FIBER INSULATION APPLICATION

- A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, 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 anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 - c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - 4. Impale insulation over anchors and attach speed washers.
 - 5. 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.
 - 6. 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 segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
 - 7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
 - 8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 - 9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
 - 10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.05 FINISHES

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 09 Painting Sections.

- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- 3.06 DUCT SYSTEM APPLICATIONS
 - A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
 - B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.
 - C. Insulate the following plenums and duct systems:
 - 1. Indoor concealed supply-, return-, and outside-air ductwork.
 - 2. Indoor exposed supply-, return-, and outside-air ductwork.
 - D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Testing agency labels and stamps.
 - 8. Nameplates and data plates.
 - 9. Access panels and doors in air-distribution systems.
- 3.07 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE
 - A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
 - B. Concealed, round and rectangular, supply-air duct insulation shall be one of the following:
 - 1. Retain one or both subparagraphs below.
 - 2. Mineral-Fiber Blanket: 3 inches (75 mm) and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 - 3. Mineral-Fiber Board: 3 inches (75 mm) thick and 6-lb/cu. ft. (96-kg/cu. m) nominal density.
 - C. Concealed, round and rectangular, return-air duct insulation shall be one of the following:
 - 1. Retain one or both subparagraphs below.
 - 2. Mineral-Fiber Blanket: 3 inches (75 mm) and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

- 3. Mineral-Fiber Board: 3 inches (75 mm) thick and 6-lb/cu. ft. (96-kg/cu. m) nominal density.
- D. Concealed, supply-air plenum insulation shall be one of the following:
 - 1. Retain one or both subparagraphs below.
 - 2. Mineral-Fiber Blanket: 3 inches (75 mm) and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 - 3. Mineral-Fiber Board: 3 inches (75 mm) thick and 6-lb/cu. ft. (96-kg/cu. m) nominal density.
- E. Concealed, return-air plenum insulation shall be one of the following:
 - 1. Retain one or both subparagraphs below.
 - 2. Mineral-Fiber Blanket: 3 inches (75 mm) and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 - 3. Mineral-Fiber Board: 3 inches (75 mm) thick 6-lb/cu. ft. (96-kg/cu. m) nominal density.
- F. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 3 inches (75 mm) and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 - 2. Mineral-Fiber Board: 3 inches (75 mm) thick and 6-lb/cu. ft. (96-kg/cu. m) nominal density.
 - 3. Mineral-Fiber Pipe and Tank: 3 inches (75 mm) thick.
- G. Exposed, round and flat-oval, return-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 3 inches (75 mm) and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 - 2. Mineral-Fiber Board: 3 inches (75 mm) thick and 6-lb/cu. ft. (96-kg/cu. m) nominal density.
- H. Exposed, rectangular, supply-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 3 inches (75 mm) and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 - 2. Mineral-Fiber Board: 3 inches (75 mm) thick and 6-lb/cu. ft. (96-kg/cu. m) nominal density.
- I. Exposed, rectangular, return-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 3 inches (75 mm) and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 - 2. Mineral-Fiber Board: 3 inches (75 mm) thick and 6-lb/cu. ft. (96-kg/cu. m) nominal density.
- J. Exposed, supply-air plenum insulation shall be one of the following:

- 1. Mineral-Fiber Blanket: 3 inches (75 mm) and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- 2. Mineral-Fiber Board: 3 inches (75 mm) thick and 6-lb/cu. ft. (96-kg/cu. m) nominal density.
- K. Exposed, return-air plenum insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 3 inches (75 mm) and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 - 2. Mineral-Fiber Board: 3 inches (75 mm) thick and 6-lb/cu. ft. (96-kg/cu. m) nominal density.

END OF SECTION

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Condensate drain piping, indoors and outdoors.
 - 2. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
 - 1. Section 23 07 13 "Duct Insulation."

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, watervapor permeance thickness, and jackets (both factory and field applied if any).
- 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.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. 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 smokedeveloped index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smokedeveloped index of 150 or less.

1.06 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.
- 1.07 COORDINATION
 - A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
 - B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
 - C. Coordinate installation and testing of heat tracing.

1.08 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping 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. Calcium Silicate:
 - 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. Industrial Insulation Group (IIG); Thermo-12 Gold.
 - 2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
- G. 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: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 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.
- H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I, or II with factory-applied vinyl jacket, III with factory-applied FSK jacket or III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. 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.
- J. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000-Degree Pipe Insulation.
 - c. Manson Insulation Inc.; Alley-K.
 - d. Owens Corning; Fiberglas Pipe Insulation.
 - Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factoryapplied jacket, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, without factory-applied jacket, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- K. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer,

vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Knauf Insulation; Permawick Pipe Insulation.
 - b. Owens Corning; VaporWick Pipe Insulation.
- L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ or FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Manson Insulation Inc.; AK Flex.
 - e. Owens Corning; Fiberglas Pipe and Tank Insulation.
- M. Phenolic:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Kingspan Tarec Industrial Insulation NV; Koolphen K.
 - b. Resolco International BV; Insul-phen.
 - 2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
 - 3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
 - 4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - a. Preformed Pipe Insulation: ASJ.
- N. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); Trymer 2000 XP.
 - b. Duna USA Inc.; Corafoam.
 - c. Dyplast Products; ISO-25.
 - d. Elliott Company of Indianapolis; Elfoam.

- Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
- 3. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thickness up to 1 inch (25 mm) as tested by ASTM E 84.
- 4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
- 5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - a. Pipe Applications: ASJ, ASJ-SSL, PVDC or PVDC-SSL.
- O. 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: Subject to compliance with requirements, provide one of the following:
 - a. Armacell LLC; Tubolit.
 - b. Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
- P. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); Styrofoam.

2.02 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 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. Ramco Insulation, Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 - 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. Ramco Insulation, Inc.; Thermokote V.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 - 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. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.03 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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97.
 - b. Eagle Bridges Marathon Industries; 290.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
 - d. Mon-Eco Industries, Inc.; 22-30.
 - e. Vimasco Corporation; 760.
 - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. 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. 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 (minus 73 to plus 93 deg C).
 - 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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. 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."
- D. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-96.

- b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-33.
- 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 3. 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."
- E. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aeroseal.
 - b. Armacell 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.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. 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."
- F. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers 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. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. 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."
- G. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-96.
- b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60.
- H. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - 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.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. 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."
- I. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - 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. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. 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."
- 2.04 MASTICS
 - A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - 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 (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
- 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
- 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
 - b. Eagle Bridges Marathon Industries; 501.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
 - d. Mon-Eco Industries, Inc.; 55-10.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
 - 3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
 - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
 - b. Eagle Bridges Marathon Industries; 570.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30mil (0.8-mm) dry film thickness.
 - 3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
 - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - 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 (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
- 4. Solids Content: 60 percent by volume and 66 percent by weight.
- 5. Color: White.

2.05 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
 - 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
 - 5. Color: White.

2.06 SEALANTS

- A. Joint Sealants:
 - 1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
 - 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. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-70.
 - 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.
- 3. Materials shall be compatible with insulation materials, jackets, and substrates.
- 4. Permanently flexible, elastomeric sealant.
- 5. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
- 6. Color: White or gray.
- 7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 8. Sealants 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."
- B. FSK and Metal Jacket Flashing Sealants:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - 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 (Minus 40 to plus 121 deg C).
 - 5. Color: Aluminum.
 - 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 7. Sealants 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 Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 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. 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 (Minus 40 to plus 121 deg C).
- 5. Color: White.
- 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 7. Sealants 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."

2.07 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- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric 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: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - 6. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric 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: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

- 7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylicbased adhesive covered by a removable protective strip.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) 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 (0.86 metric perms) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.08 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
 - 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.

2.09 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: Color-code jackets based on system. Color as selected by Architect.
 - 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. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - 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. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 2.5-mil- (0.063-mm-) thick polysurlyn.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heatbonded polyethylene and kraft paper.
 - e. 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.

- 3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 2.5-mil- (0.063-mm-) thick polysurlyn.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heatbonded polyethylene and kraft paper.
 - e. 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.
- E. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) 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 or 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.
- F. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric 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: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film.
- G. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smokedeveloped index of 25 when tested according to ASTM E 84.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Dow Chemical Company (The); Saran 560 Vapor Retarder Film.
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. 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 (75 mm).
 - 3. Thickness: 11.5 mils (0.29 mm).
 - 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. 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 (75 mm).
 - 3. Thickness: 6.5 mils (0.16 mm).
 - 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. ABI, Ideal Tape Division; 370 White PVC tape.
- b. Compac Corporation; 130.
- c. Venture Tape; 1506 CW NS.
- 2. Width: 2 inches (50 mm).
- 3. Thickness: 6 mils (0.15 mm).
- 4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
- 5. Elongation: 500 percent.
- 6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - 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 (50 mm).
 - 3. Thickness: 3.7 mils (0.093 mm).
 - 4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
 - 5. Elongation: 5 percent.
 - 6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
 - 2. Width: 3 inches (75 mm).
 - 3. Film Thickness: 4 mils (0.10 mm).
 - 4. Adhesive Thickness: 1.5 mils (0.04 mm).
 - 5. Elongation at Break: 145 percent.
 - 6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
 - 2. Width: 3 inches (75 mm).
 - 3. Film Thickness: 6 mils (0.15 mm).
 - 4. Adhesive Thickness: 1.5 mils (0.04 mm).
 - 5. Elongation at Break: 145 percent.
 - 6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.12 SECUREMENTS

- A. Bands:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
 - 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 3/4 inch (19 mm) wide with wing seal or closed seal.
 - 3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing seal or closed seal.
 - 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
- C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy, 0.062-inch (1.6-mm) soft-annealed, stainless steel or 0.062-inch (1.6-mm) soft-annealed, galvanized steel.
 - 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. C & F Wire.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems 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.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a

temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

- 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 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- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, 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 (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

- 1. Seal penetrations with flashing sealant.
- 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
- 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
- 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 - 4. Seal jacket to wall flashing with flashing sealant.
- 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: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- E. 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 07 84 13 "Penetration Firestopping."

3.05 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 (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
- 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF CALCIUM SILICATE INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
 - 2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
 - 3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
- 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 block insulation of same material and thickness as pipe insulation.
 - 4. Finish flange insulation same as pipe insulation.
- 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 insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
 - 3. Finish fittings insulation same as pipe insulation.
- D. Insulation Installation on Valves and Pipe Specialties:

- 1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
- 2. Install insulation to flanges as specified for flange insulation application.
- 3. Finish valve and specialty insulation same as pipe insulation.

3.07 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 (150 mm) 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 (25 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available. 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.

3.08 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.

3.09 INSTALLATION OF MINERAL-FIBER 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 (150 mm) 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 (25 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF PHENOLIC INSULATION

- A. General Installation Requirements:
 - 1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
 - Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
- B. 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 (150 mm) o.c.
 - 4. For insulation with factory-applied jackets with vapor retarders 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.
- C. 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 block insulation of same material and thickness as pipe insulation.
- D. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- E. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
 - 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.

3.11 INSTALLATION OF POLYISOCYANURATE INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
 - 2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
 - 3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
- 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, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
- C. Insulation Installation on Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- D. Insulation Installation on Valves and Pipe Specialties:

- 1. Install preformed sections of polyisocyanurate 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.

3.12 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.

3.13 INSTALLATION OF POLYSTYRENE INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
 - 2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as

recommended by insulation material manufacturer and seal with vapor-barrier mastic.

- 3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
- 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, and make thickness same as adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm).
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed section of polystyrene 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.

3.14 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 (50-mm) overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

- C. Where PVC jackets are indicated, install with 1-inch (25-mm) 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.
- D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.
- E. 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-presized 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 (50 mm) 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 (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) 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.

3.15 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "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.
- 3.16 FIELD QUALITY CONTROL
 - A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - B. Perform tests and inspections.
 - C. Tests and Inspections:
 - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, 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 for each pipe service defined in the "Piping Insulation Schedule, General" Article.
 - D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
- 3.17 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.
- 3.18 INDOOR PIPING INSULATION SCHEDULE
 - A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
 - c. Phenolic: 1 inch (25 mm) thick.
 - d. Polyisocyanurate: 1 inch (25 mm) thick.
 - e. Polyolefin: 1 inch (25 mm) thick.
 - B. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches (50 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
 - c. Phenolic: 2 inches (50 mm) thick.
 - d. Polyisocyanurate: 2 inches (50 mm) thick.
 - e. Polyolefin: 2 inches (50 mm) thick.
 - C. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be one of the following:

- a. Flexible Elastomeric: 2 inches (50 mm) thick.
- b. Polyolefin: 2 inches (50 mm) thick.

3.19 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches (50 mm) thick.
 - b. Flexible Elastomeric: 2 inches (50 mm) thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
 - d. Phenolic: 2 inches (50 mm) thick.
 - e. Polyisocyanurate: 2 inches (50 mm) thick.
 - f. Polyolefin: 2 inches (50 mm) thick.
 - g. Polystyrene: 2 inches (50 mm) thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 2 inches (50 mm) thick.
 - b. Polyolefin: 2 inches (50 mm) thick.
- 3.20 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. None.
 - D. Piping, Exposed:
 - 1. PVC, Color-Coded by System: 30 mils (0.8 mm) thick.
 - 2. Aluminum, Smooth, Corrugated or Stucco Embossed: 0.040 inch (1.0 mm) thick.
 - 3. Painted Aluminum, Smooth, Corrugated or Stucco Embossed: 0.032 inch (0.81 mm) thick.
 - 4. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish, Corrugated or Stucco Embossed: 0.024 inch (0.61 mm) thick.
- 3.21 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. None.
- 2. PVC PVC, Color-Coded by System: 30 mils (0.8 mm) thick.
- 3. Aluminum, Smooth, Corrugated or Stucco Embossed: 0.040 inch (1.0 mm) thick.
- 4. Painted Aluminum, Smooth, Corrugated or Stucco Embossed: 0.032 inch (0.81 mm) thick.
- 5. Stainless Steel, Type 304, 316, 304 or 316, Smooth 2B Finish, Corrugated or Stucco Embossed: 0.024 inch (0.61 mm) thick.
- D. Piping, Exposed:
 - 1. PVC: 40 mils (1.0 mm) thick.
 - 2. Painted Aluminum, Smooth, Corrugated, Stucco Embossed or with Z-Shaped Locking Seam: 0.040 inch (1.0 mm) thick.
 - 3. Stainless Steel, Type 304, 316, 304 or 316, Smooth 2B Finish, Corrugated, Stucco Embossed or with Z-Shaped Locking Seam: 0.024 inch (0.61 mm) thick.

END OF SECTION

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. The Direct-Digital Control (DDC) System specified herein shall include materials, operator workstation, building controllers, sensors, control valves, wiring, installation, start-up, testing, documentation and training for a complete operable system as required for this project.
- B. Controls Engineering shall be provided by the local controls manufacture representative.
- C. Work specified under this section shall be performed by, or under the direct supervision of the local controls manufacture representative, or by a contractor that is certified by the controls manufacture to perform all work within Section 23 09 00 Instrumentation and Control for HVAC and those sections of 23 09 00 that have been specified herein.
- D. Alternate techniques, modifications or changes to any aspect of these specifications may be submitted as a voluntary alternate no later than (15) days prior to the bid date and with sufficient information for a complete evaluation. This information shall include product data sheets, a UL508A Standard for Industrial Control Panels statement of compliance for any locally manufactured control panels, a detailed sequence of operation and engineered shop drawing. Shop drawings shall include the following as a minimum. Point to point wiring diagrams for each piece of equipment to be controlled, a network riser diagram that will depict quantity and location of all operator workstation, controllers, routers and repeaters required for this project.

1.02 RELATED SECTIONS

- A. Division 00 and 01: Procurement and Contracting Requirements and General Requirements
- B. 23 00 10: Mechanical General Requirements
- C. Division 26: Electrical

1.03 SUBMITTALS

- A. Submit engineered shop drawings, sequences of operation, third party equipment and controls integration points and product data sheets covering all items of equipment for the proposed system prior to installation for approval. Any deviation from the contract documents shall be noted and the drawings signed and dated by the Contractor. Additionally, submit a UL508A Standard for Industrial Control Panels statement of compliance for any locally manufactured control panels.
- B. After completion of the installation and commissioning, a full set of as-built documentation shall be turned over to the Owner. The as-built shall include operation

and maintenance manuals, sequence of operation, shop drawings and digital copies of the following.

- 1. Complete DDC System databases backup
- 2. Source files for all custom written controller applications
- 3. Source files for graphics if required for this project

1.04 WARRANTY

- A. Components, system software, and parts shall be guaranteed against defects in materials, fabrication, and execution for (1) year from date of system acceptance. Provide labor and materials to repair, reprogram, or replace components at no charge to the Owner during the warranty period.
- B. Provide a list of applicable warranties for components, this list shall include warranty information, names, addresses, telephone numbers, and procedures for filing a claim and obtaining warranty services.
- C. Respond to the Owner's request for warranty service within (24) hours during normal business hours. Submit records of the nature of the call, the work performed, and the parts replaced or service rendered.
- 1.05 TRAINING
 - A. Provide a competent instructor who is factory trained and has comprehensive knowledge of system components and operations to provide full instructions to designated personnel in the system operation, maintenance, and programming. Training shall be specifically oriented to installed equipment and systems.
 - B. Provide (4) hours of onsite owner familiarization and training for the installed system. Training shall include system overview, time schedules, emergency operation, and programming and report generation.
 - C. Owner employees attending this training session shall be provided with the following documentation:
 - 1. System layout point to point connection diagram.
 - 2. System components cut sheets.
 - 3. Operations and maintenance data.
 - D. Provide classroom training for (1) owner technician, classes to include Carrier CS Level training with a total of (24) hours per student.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Do not store or install electronic hardware on the project until non-condensing environmental conditions have been established.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

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- A. DDC Equipment: Carrier OPEN BACnet Controls to match Equipment Manufacturer
- B. Controls installation will be by Russell Sigler Inc. Controls Group.
- C. The local manufacture representative will operate a free 40 hour a week, toll free customer support hotline for additional user support services that are required.
- 2.02 SYSTEM LISTING COMPLIANCE
 - A. Locally manufactured control panels shall meet all requirements as outlined by UL 508A standard and shall be both approved and listed by Underwriters Laboratories, Inc.
- 2.03 COMMUNICATION
 - A. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
 - B. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
 - C. Use owner provided Ethernet backbone for network segments.

2.04 OPERATOR INTERFACE

- A. Description. The control system shall be as shown and consist of a high-speed, peer-topeer network of DDC controllers and a stand-alone web server operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators with sufficient access level shall have an ability to make changes to all system and equipment graphics in the web server in addition to having full DDC system access to make configuration changes to the control system. Any tools required for making graphic changes shall be provided with web server.
- B. Operator Interface. Furnish (1) Web server interface as shown on the system drawings.
 - 1. With the use of an owner provided remote SMTP email server the operators interface web server shall notify personnel of an alarm and record information about an alarm in the DDC system.
 - 2. Any required installation or commissioning software shall be provided to the owner.
- C. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
 - 1. Log In and Log Out
 - 2. Point-and-click Navigation
 - 3. View and Adjust Equipment Properties
 - 4. View and Adjust Operating Schedules
 - 5. View and Respond to Alarms
 - 6. View and Configure Trends

- 7. Manage Control System Hardware
- 8. Manage Operator Access
- D. System Graphics. Operator interface shall be graphical and shall include at least one graphic per piece of equipment and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
- E. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs.
- F. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Furnish the following standard system reports:
 - 1. Alarm Reports
 - 2. Schedule Reports
 - 3. Security Reports
 - 4. Commissioning Reports
 - 5. Equipment Reports

2.05 CONTROLLERS

- A. General. The control system shall be available as a complete package with the required input sensors and devices readily available. Provide BACnet Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), and Sensors (SEN) as required.
- B. Stand-Alone Operation. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure.
- C. Serviceability. Controllers shall have diagnostic LEDs for power, communication, and processor.
- D. Rooftop Unit Controller (RTC). Defined as Application Specific Controllers (ASC), shall be factory installed by the HVAC manufacturer and shall control all associated HVAC rooftop equipment functions in a single zone application or as part of a zoning system application.
 - 1. Capacity control shall be based by the RTC internal time clock and setpoints (cooling and heating) coupled with a communicating room sensor. The controls shall provide separate occupied and unoccupied cooling and heating setpoints.
 - 2. RTC shall utilize up to 2 speed of fan control, up to 3 stages of cooling, and up to 4 stages of heating.
 - 3. RTC shall provide economizer control that has been certified for Fault Detection and Diagnostics (FDD) by California Energy Commission (CEC). The FDD system shall detect the following faults:
 - a. Air temperature sensor failure/fault
 - b. Not economizing when it should
 - c. Economizing when it should not

- d. Damper not modulating
- e. Excess outdoor air
- E. General Purpose Controller. Defined as Advanced Application Controller (AAC) shall be a solid state micro-controller with pre-tested and factory configured software designed for controlling building equipment using DDC algorithms and facility management routines. The controller shall be capable of operating in either a stand-alone mode or as part of a network.

2.06 FIELD INSTALLED SENSORS

- A. Space Temperature Sensors shall communicate to the controller over a 4-wire communication network and have setpoint adjustment, after hours override, LCD display and a communication service port.
- B. Status indication for fans or pumps shall be provided by a split core design current sensing sensor. The sensor shall be installed at the motor starter or motor to provide load indication. The unit shall consist of a current transformer, a solid state current sensing circuit (with adjustable set point) and a solid state switch. A light emitting diode (LED) shall indicate the on off status of the unit.

2.07 CONTROL PANELS

- A. Provide single-door, UL 508A Listed; Type 4, wall-mount enclosures for the EMCS Controller, as shown on the plans. Mount relays, switches, and controllers in cabinet and indicators, pilot lights, push buttons and switches flush on enclosure exterior face as required.
- B. Fabricate panels from 16 gauge steel with ANSI 61 gray finish and shall include (1) black padlock handle that will accommodate a padlock with up to a 5/16-in. locking bar for secure access to the enclosure contents. All additional latches shall be black non-locking handle type.
- C. Provide engraved name plates that identify each control panel and for each component mounted to the exterior of the enclosure.
- D. Provide a complete wiring diagram, bill of material for all components and markings with the following information:
 - 1. Manufacturer's name or trademark
 - 2. Supply voltage, number of phases, frequency, and full-load current for each incoming supply circuit
 - 3. Enclosure type number

PART 3 - EXECUTION

- 3.01 ELECTRICAL WIRING
 - A. This contractor is responsible for all low voltage electrical installation and wiring for a fully operational DDC System as shown on the drawings and shall perform electrical

installation in accordance with local and national electrical codes and in accordance with Division 26.

- B. Install all HVAC control wiring, 24vdc or less, in electrical metallic tubing (EMT). Rigid metal conduit (RMC) will be used when conduit will be installed on roofs.
- C. Electrical Contractor is responsible for providing power from local electrical panels to the DDC System control panels.
- D. When transitioning between buildings above or below ground level, provide a pull box with necessary surge suppression hardware to transition exterior rated wiring to interior applications.

3.02 ACCEPTANCE PROCEDURE

- A. Upon completion of the installation, the contractor shall start-up the system and perform all necessary calibration and testing to ensure the proper operation of the DDC System.
- B. After all calibration and testing have been completed, the contractor shall schedule a hardware demonstration and system acceptance test to be performed in the presence of the designated owner's representatives.

END OF SECTION

SECTION 23 11 23

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to DSA anchorage notes on sheet M0.01.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.04 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
 - 2. Service Regulators: 100 psig (690 kPa) minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less.
- 1.05 ACTION SUBMITTALS
 - A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated, stainless-steel tubing with associated components.

- 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
- 4. Pressure regulators. Indicate pressure ratings and capacities.
- 5. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - 1. Shop Drawing Scale: 1/4 inch per foot (1:50).
 - 2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.
- C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.
- 1.07 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.
- 1.08 QUALITY ASSURANCE
 - A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
 - B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 1.09 DELIVERY, STORAGE, AND HANDLING
 - A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
 - B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
 - C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
 - D. Protect stored PE pipes and valves from direct sunlight.
- 1.10 PROJECT CONDITIONS
 - A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
 - B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Architect Construction Manager Owner no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Architect's Construction Manager's Owner's written permission.

1.11 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 08 31 13 "Access Doors and Frames."

PART 2 - PRODUCTS

- 2.01 PIPES, TUBES, AND FITTINGS
 - A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.

- 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
- 4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- B. PE Pipe: ASTM D 2513, SDR 11.
 - 1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 - 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
- 2.02 PIPING SPECIALTIES
 - A. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 4. Corrugated stainless-steel tubing with polymer coating.
 - 5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
 - 6. End Fittings: Zinc-coated steel.
 - 7. Threaded Ends: Comply with ASME B1.20.1.
 - 8. Maximum Length: 72 inches (1830 mm.)
 - B. 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 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) 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 (862 kPa).

- C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosionresistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.
- 2.03 JOINING MATERIALS
 - A. Joint Compound and Tape: Suitable for natural gas.
 - B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
 - C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.
- 2.04 MANUAL GAS SHUTOFF VALVES
 - A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
 - B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig (862 kPa).
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
 - 6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
 - C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig (862 kPa).
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
 - D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BrassCraft Manufacturing Company; a Masco company.

- b. Conbraco Industries, Inc.; Apollo Div.
- c. Lyall, R. W. & Company, Inc.
- d. McDonald, A. Y. Mfg. Co.
- e. Perfection Corporation; a subsidiary of American Meter Company.
- 2. Body: Bronze, complying with ASTM B 584.
- 3. Ball: Chrome-plated brass.
- 4. Stem: Bronze; blowout proof.
- 5. Seats: Reinforced TFE; blowout proof.
- 6. Packing: Separate packnut with adjustable-stem packing threaded ends.
- 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
- 8. CWP Rating: 600 psig (4140 kPa).
- 9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
- 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. PE Ball Valves: Comply with ASME B16.40.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kerotest Manufacturing Corp.
 - b. Lyall, R. W. & Company, Inc.
 - c. Perfection Corporation; a subsidiary of American Meter Company.
 - 2. Body: PE.
 - 3. Ball: PE.
 - 4. Stem: Acetal.
 - 5. Seats and Seals: Nitrile.
 - 6. Ends: Plain or fusible to match piping.
 - 7. CWP Rating: 80 psig (552 kPa).
 - 8. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
 - 9. Operator: Nut or flat head for key operation.
 - 10. Include plastic valve extension.
 - 11. Include tamperproof locking feature for valves where indicated on Drawings.
- F. Valve Boxes:
 - 1. Cast-iron, two-section box.
 - 2. Top section with cover with "GAS" lettering.
 - 3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
 - 4. Adjustable cast-iron extensions of length required for depth of bury.
 - 5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.05 EARTHQUAKE VALVES

- A. Earthquake Valves: Comply with ASCE 25.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Vanguard Valves, Inc.
 - 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 3. Maximum Operating Pressure: 5 psig (34.5 kPa).
 - 4. Cast-aluminum body with nickel-plated chrome steel internal parts.
 - 5. Nitrile-rubber valve washer.
 - 6. Sight windows for visual indication of valve position.
 - 7. Threaded end connections complying with ASME B1.20.1.
 - 8. Wall mounting bracket with bubble level indicator.

2.06 PRESSURE REGULATORS

- A. General Requirements:
 - 1. Single stage and suitable for natural gas.
 - 2. Steel jacket and corrosion-resistant components.
 - 3. Elevation compensator.
 - 4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.
- B. Service Pressure Regulators: Comply with ANSI Z21.80.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - d. Invensys.
 - e. Richards Industries; Jordan Valve Div.
 - 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 - 3. Springs: Zinc-plated steel; interchangeable.
 - 4. Diaphragm Plate: Zinc-plated steel.
 - 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 - 6. Orifice: Aluminum; interchangeable.
 - 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 - 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.

- 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
- 10. Overpressure Protection Device: Factory mounted on pressure regulator.
- 11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
- 12. Maximum Inlet Pressure: 100 psig (690 kPa).

2.07 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: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. 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: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.08 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

- 3.01 EXAMINATION
 - A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
 - B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.
- 3.03 OUTDOOR PIPING INSTALLATION
 - A. Comply with NFPA 54 for installation and purging of natural-gas piping.
 - B. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.
 - C. Install underground, PE, natural-gas piping according to ASTM D 2774.
 - D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
 - E. Copper Tubing with Protective Coating:
 - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - F. Install fittings for changes in direction and branch connections.
 - G. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 23 05 19 "Meters and Gages for HVAC Piping."
- 3.04 INDOOR PIPING INSTALLATION
 - A. Comply with NFPA 54 for installation and purging of natural-gas piping.
 - B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed naturalgas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs

with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

- 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
- 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
- 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 23 05 19 "Meters and Gages for HVAC Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

3.05 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainlesssteel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.
- 3.06 PIPING JOINT CONSTRUCTION
 - A. Ream ends of pipes and tubes and remove burrs.
 - B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
 - D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
 - E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
 - F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
 - G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

- H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.07 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements for pipe hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
 - 2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 - 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 - 4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
- 3.08 CONNECTIONS
 - A. Connect to utility's gas main according to utility's procedures and requirements.
 - B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
 - C. Install piping adjacent to appliances to allow service and maintenance of appliances.
 - D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
 - E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.
- 3.09 LABELING AND IDENTIFYING
 - A. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for piping and valve identification.
 - B. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.10 PAINTING

- A. Comply with requirements in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Color: Gray.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive Quick-drying alkyd metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Color: Gray.
 - 2. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Alkyd anticorrosive Quick-drying alkyd metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.

- 6. Use 3000-psig (20.7-MPa), 28-day, compressive-strength concrete and reinforcement as specified in Section 03 30 00 "Cast-in-Place Concrete."
- 3.12 FIELD QUALITY CONTROL
 - A. Perform tests and inspections.
 - B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
 - C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
- 3.13 DEMONSTRATION
 - A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.
- 3.14 OUTDOOR PIPING SCHEDULE
 - A. Underground natural-gas piping shall be the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
 - B. Aboveground natural-gas piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
 - C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.
 - D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- 3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)
 - A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - B. Aboveground, distribution piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.

- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.
- 3.16 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE
 - A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
 - B. Underground:
 - 1. PE valves.
 - 2. NPS 2 (DN 50) and Smaller: Bronze plug valves.
- 3.17 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE
 - A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - B. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - C. Valves in branch piping for single appliance shall be the following:
 - 1. One-piece, bronze ball valve with bronze trim.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:
 - 1. Hot-water heating piping.
 - 2. Condenser-water piping.
 - 3. Makeup-water piping.
 - 4. Air-vent piping.
 - 5. Safety-valve-inlet and -outlet piping.

1.03 ACTION SUBMITTALS

- A. Delegated-Design Submittal:
 - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
 - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
 - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
 - 4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Other building services.
 - 3. Structural members.
- B. Qualification Data: For Installer.
- C. Welding certificates.
- D. Field quality-control reports.

- E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.
- 1.05 QUALITY ASSURANCE
 - A. Installer Qualifications:
 - 1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
 - 2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.
 - B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
 - C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

- 2.01 PERFORMANCE REQUIREMENTS
 - A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Hot-Water Heating Piping: at 200 deg F.
 - 2. Condenser-Water Piping: at 150 deg F.
 - 3. Makeup-Water Piping: 80 psig at 150 deg F.
 - 4. Air-Vent Piping: 200 deg F.
 - 5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.
- 2.02 COPPER TUBE AND FITTINGS
 - A. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).
 - B. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).
 - C. Wrought-Copper Unions: ASME B16.22.
- 2.03 STEEL PIPE AND FITTINGS
 - A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "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 "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.
- 2.04 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 otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
 - C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
 - D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
 - E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
 - F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.05 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: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. Watts Regulator Co.
 - d. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 250 psig
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Matco-Norca.
 - b. Watts Regulator Co.
 - c. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 300 psig
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.

- b. Pressure Rating: 150 psig.
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elster Perfection.
 - b. Grinnell Mechanical Products.
 - c. Matco-Norca.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
 - 2. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig at 225 deg.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

2.06 BYPASS CHEMICAL FEEDER

- A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
 - 1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
 - 1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
 - 2. Schedule 40, Grade B, Type 96 steel pipe; Class 300, malleable-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 (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
 - 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

- C. Condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
 - 1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
 - 2. Schedule 80 or Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- D. Makeup-water piping installed aboveground shall be the following:
 - 1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered brazed joints.
- E. Condensate-Drain Piping: Type M (Type C), drawn -temper copper tubing, wroughtcopper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- F. Air-Vent Piping:
 - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 - 2. Outlet: Type K (Type A), annealed-temper copper tubing with soldered or flared joints.
- G. 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 piping manufacturer's written instructions.

3.02 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in exposed conditions unless otherwise indicated.
- C. Install piping indicated to be exposed and piping inside and outside the building at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping to permit valve servicing.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation.

- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- L. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- M. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- N. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- O. Install valves according to Section 23 05 23 "General-Duty Valves for HVAC Piping."
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install shutoff valve immediately upstream of each dielectric fitting.
- S. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for identifying piping.
- T. Install sleeves for piping penetrations of walls and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

3.03 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 nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits or nipples.
3.04 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section 23 05 48 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- 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.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS ³/₄: Maximum span, 7 feet.
 - 2. NPS 1: Maximum span, 7 feet.
 - 3. NPS 1-1/2: Maximum span, 9 feet.
 - 4. NPS 2: Maximum span, 10 feet.
 - 5. NPS 2-1/2: Maximum span, 11 feet.
 - 6. NPS 3 and Larger: Maximum span, 12 feet.
- 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 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 7. NPS 3 and Larger: 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.
- 3.05 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/A5.8M.
- 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. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- 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.
- 3.06 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. Comply with requirements in Section 23 05 19 "Meters and Gages for HVAC Piping."
- 3.07 CHEMICAL TREATMENT
 - A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

- 1. pH: 9.0 to 10.5.
- 2. "P" Alkalinity: 100 to 500 ppm.
- 3. Boron: 100 to 200 ppm.
- 4. Chemical Oxygen Demand: Maximum of 100 ppm. Revise this value if closed system contains glycol.
- 5. Corrosion Inhibitor:
 - a. Sodium Nitrate: 1000 to 1500 ppm.
 - b. Molybdate: 200 to 300 ppm.
 - c. Chromate: 200 to 300 ppm.
 - d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
 - e. Chromate Plus Molybdate: 50 to 100 ppm each.
- 6. Soluble Copper: Maximum of 0.20 ppm.
- 7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of 10 ppm.
- 8. Total Suspended Solids: Maximum of 10 ppm.
- 9. Ammonia: Maximum of 20 ppm.
- 10. Free Caustic Alkalinity: Maximum of 20 ppm.
- 11. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maximum of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maximum of 100 organisms/mL.
 - c. Nitrate Reducers: 100 organisms/mL.
 - d. Sulfate Reducers: Maximum of zero organisms/mL.
 - e. Iron Bacteria: Maximum of zero organisms/mL.
- B. Install bypass chemical feeders in each hydronic system where indicated.
 - 1. Install in upright position with top of funnel not more than 48 inches above the floor.
 - 2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
 - 3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.
- C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.08 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 the "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, to specified values.
 - 7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 23 21 16

HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes special-duty valves and specialties for the following:
 - 1. Hot-water heating piping.
 - 2. Makeup-water piping.
 - 3. Condenser water piping.
 - 4. Air-vent piping.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air-control devices.
 - 3. Hydronic specialties.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.06 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. 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

2.01 VALVES

- A. Bronze, Calibrated-Orifice, Balancing Valves:
 - 1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
 - 2. Ball: Brass or stainless steel.
 - 3. Plug: Resin.
 - 4. Seat: PTFE.
 - 5. End Connections: Threaded or socket.
 - 6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 7. Handle Style: Lever, with memory stop to retain set position.
 - 8. CWP Rating: Minimum 125 psig (860 kPa).
 - 9. Maximum Operating Temperature: 250 deg F (121 deg C).
- B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
 - 1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
 - 2. Ball: Brass or stainless steel.
 - 3. Stem Seals: EPDM O-rings.
 - 4. Disc: Glass and carbon-filled PTFE.
 - 5. Seat: PTFE.
 - 6. End Connections: Flanged or grooved.
 - 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 8. Handle Style: Lever, with memory stop to retain set position.
 - 9. CWP Rating: Minimum 125 psig (860 kPa).
 - 10. Maximum Operating Temperature: 250 deg F (121 deg C).
- C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
 - 1. Body: Bronze or brass.
 - 2. Disc: Glass and carbon-filled PTFE.
 - 3. Seat: Brass.
 - 4. Stem Seals: EPDM O-rings.
 - 5. Diaphragm: EPT.
 - 6. Low inlet-pressure check valve.
 - 7. Valve Seat and Stem: Noncorrosive.
 - 8. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- D. Diaphragm-Operated Safety Valves: ASME labeled.
 - 1. Body: Bronze or brass.
 - 2. Disc: Glass and carbon-filled PTFE.
 - 3. Seat: Brass.
 - 4. Stem Seals: EPDM O-rings.
 - 5. Diaphragm: EPT.

- 6. Wetted, Internal Work Parts: Brass and rubber.
- 7. Valve Seat and Stem: Noncorrosive.
- 8. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- E. Automatic Flow-Control Valves:
 - 1. Body: Brass or ferrous metal.
 - 2. Piston and Spring Assembly: Stainless steel , tamper proof, self-cleaning, and removable.
 - 3. Combination Assemblies: Include bronze or brass-alloy ball valve.
 - 4. Identification Tag: Marked with zone identification, valve number, and flow rate.
 - 5. Size: Same as pipe in which installed.
 - 6. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
 - 7. Minimum CWP Rating: 175 psig (1207 kPa
 - 8. Maximum Operating Temperature: 200 deg F (93 deg C)

2.02 AIR-CONTROL DEVICES

- A. Manual Air Vents:
 - 1. Body: Bronze.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Screwdriver or thumbscrew.
 - 4. Inlet Connection: NPS 1/2 (DN 15).
 - 5. Discharge Connection: NPS 1/8 (DN 6).
 - 6. CWP Rating: 150 psig (1035 kPa).
 - 7. Maximum Operating Temperature: 225 deg F (107 deg C).
- B. Automatic Air Vents:
 - 1. Body: Bronze or cast iron.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Noncorrosive metal float.
 - 4. Inlet Connection: NPS 1/2 (DN 15).
 - 5. Discharge Connection: NPS 1/4 (DN 8).
 - 6. CWP Rating: 150 psig (1035 kPa).
 - 7. Maximum Operating Temperature: 240 deg F (116 deg C).
- C. Expansion Tanks:
 - Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. (379-L) unit only; sized for

compression-tank diameter. Provide tank fittings for 125-psig (860-kPa) working pressure and 250 deg F (121 deg C) maximum operating temperature.

- 3. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
- 4. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- (20-mm-) diameter gage glass, and slotted-metal glass guard.

2.03 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 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
 - 3. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
 - 4. CWP Rating: 125 psig (860 kPa).
- B. Basket Strainers:
 - 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
 - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig (860 kPa).
- C. T-Pattern Strainers:
 - 1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
 - 2. End Connections: Grooved ends.
 - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
 - 4. CWP Rating: 750 psig (5170 kPa).
- D. 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 (20-mm) misalignment.
 - 4. CWP Rating: 150 psig (1035 kPa).
 - 5. Maximum Operating Temperature: 250 deg F (121 deg C).
- E. Spherical, Rubber, Flexible Connectors:
 - 1. Body: Fiber-reinforced rubber body.

- 2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
- 3. Performance: Capable of misalignment.
- 4. CWP Rating: 150 psig (1035 kPa).
- 5. Maximum Operating Temperature: 250 deg F (121 deg C).

PART 3 - EXECUTION

- 3.01 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 auto flow control valves where shown on the design documents.
 - C. Install check valves at each pump discharge and elsewhere as required to control flow direction.
 - D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
 - E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
- 3.02 HYDRONIC SPECIALTIES INSTALLATION
 - A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
 - B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
 - C. Install piping from boiler air outlet, air separator to expansion tank with a 2 percent upward slope toward tank.
 - D. Install expansion tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - 1. Install tank fittings that are shipped loose.
 - 2. Support tank from structural steel frame with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water.

END OF SECTION

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Close-coupled, in-line centrifugal pumps.
- 1.03 DEFINITIONS
 - A. Buna-N: Nitrile rubber.
 - B. EPT: Ethylene propylene terpolymer.
- 1.04 ACTION SUBMITTALS
 - A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
 - B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.01 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grundfos Pumps, Inc
 - 2. TACO Incorporated
 - 3. Armstrong Pumps, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, TEFC Outdoor rated closecoupled, in-line pump designed for installation with pump and motor shafts mounted vertically.
- PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine structural steel frame for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.02 PUMP INSTALLATION
 - A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
 - B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
 - C. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation and seismic control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

3.03 ALIGNMENT

- A. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- B. Comply with pump and coupling manufacturers' written instructions.

C. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.04 CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- D. Install check valve and throttling valve with memory stop on discharge side of pumps.
- E. Install flexible connectors on suction and discharge sides of pumps between pump casing and valves.
- F. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.05 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to DSA anchorage notes on sheet M0.01.
- 1.02 SUMMARY
 - A. This Section includes refrigerant piping used for air-conditioning applications.
- 1.03 PERFORMANCE REQUIREMENTS
 - A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
 - 2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
 - 3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Hot-gas bypass valves.
 - 4. Filter dryers.
 - 5. Strainers.
 - 6. Pressure-regulating valves.
- 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. Shop Drawing Scale: 1/4 inch equals 1 foot (1:50).
 - 2. 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.

- 1.05 INFORMATIONAL SUBMITTALS
 - A. Welding certificates.
 - B. Field quality-control test reports.
- 1.06 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.
- 1.07 QUALITY ASSURANCE
 - A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
 - C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
- 1.08 PRODUCT STORAGE AND HANDLING
 - A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.
- 1.09 COORDINATION
 - A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."
- PART 2 PRODUCTS
- 2.01 COPPER TUBE AND FITTINGS
 - A. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B) or 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 (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
- 4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
- 5. Maximum Operating Temperature: 250 deg F (121 deg C).
- 2.02 STEEL PIPE AND FITTINGS
 - A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, and wall thickness as selected in Part 3 piping applications articles.
 - B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.
 - C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
 - D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
 - E. Flanged Unions:
 - 1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 (DN 25 to DN 40) and ductile iron for NPS 2 to NPS 3 (DN 50 to DN 80). Apply rust-resistant finish at factory.
 - 2. Gasket: Fiber asbestos free.
 - 3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
 - 4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
 - 5. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
 - 6. Pressure Rating: Factory test at minimum 400 psig (2760 kPa).
 - 7. Maximum Operating Temperature: 330 deg F (165 deg C).
 - F. Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
 - 2. End Connections:
 - a. NPS 2 (DN 50) and Smaller: With threaded-end connections.
 - b. NPS 2-1/2 (DN 65) and Larger: With flanged-end connections.
 - 3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
 - 5. Maximum Operating Temperature: 250 deg F (121 deg C).
- 2.03 VALVES AND SPECIALTIES
 - A. Diaphragm Packless Valves:

- 1. Body and Bonnet: Forged brass or cast bronze; globe design with straightthrough 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 (3450 kPa).
- 7. Maximum Operating Temperature: 275 deg F (135 deg C).
- 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 (3450 kPa).
 - 8. Maximum Operating Temperature: 275 deg F (135 deg C).
- 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 (3.4 kPa).
 - 8. Working Pressure Rating: 500 psig (3450 kPa).
 - 9. Maximum Operating Temperature: 275 deg F (135 deg C).
- 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 (3450 kPa).
- 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 (16-GRC) conduit adapter, and 24, 115 or 208-V ac coil.
 - 6. Working Pressure Rating: 400 psig (2760 kPa).
 - 7. Maximum Operating Temperature: 240 deg F (116 deg C).
 - 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 (2760 kPa).
 - 6. Maximum Operating Temperature: 240 deg F (116 deg C).
- 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 (4.4 deg C).
 - 6. Superheat: Adjustable.
 - 7. Reverse-flow option (for heat-pump applications).
 - 8. End Connections: Socket, flare, or threaded union.
 - 9. Working Pressure Rating: 450 psig (3100 kPa).
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
 - 1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 - 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 - 3. Packing and Gaskets: Non-asbestos.
 - 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 - 5. Seat: Polytetrafluoroethylene.
 - 6. Equalizer: Internal or External.
 - 7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24, 115 or 208-V ac coil.
 - 8. End Connections: Socket.
 - 9. Throttling Range: Maximum 5 psig (34 kPa).
 - 10. Working Pressure Rating: 500 psig (3450 kPa).
 - 11. Maximum Operating Temperature: 240 deg F (116 deg C).
- I. 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 (3450 kPa).
 - 5. Maximum Operating Temperature: 275 deg F (135 deg C).
- J. 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 (3450 kPa).
- 6. Maximum Operating Temperature: 275 deg F (135 deg C).
- K. 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 (3450 kPa).
 - 7. Maximum Operating Temperature: 240 deg F (116 deg C).
- L. Replaceable-Core Filter Dryers: Comply with ARI 730.
 - 1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 - 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 - 3. Desiccant Media: Activated alumina or charcoal.
 - 4. Designed for reverse flow (for heat-pump applications).
 - 5. End Connections: Socket.
 - 6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
 - 7. Maximum Pressure Loss: 2 psig (14 kPa).
 - 8. Working Pressure Rating: 500 psig (3450 kPa).
 - 9. Maximum Operating Temperature: 240 deg F (116 deg C).
- M. Permanent Filter Dryers: Comply with ARI 730.
 - 1. Body and Cover: Painted-steel shell.
 - 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 - 3. Desiccant Media: Activated alumina or charcoal.
 - 4. Designed for reverse flow (for heat-pump applications).
 - 5. End Connections: Socket.
 - 6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
 - 7. Maximum Pressure Loss: 2 psig (14 kPa).
 - 8. Working Pressure Rating: 500 psig (3450 kPa).
 - 9. Maximum Operating Temperature: 240 deg F (116 deg C).
- N. Mufflers:
 - 1. Body: Welded steel with corrosion-resistant coating.
 - 2. End Connections: Socket or flare.
 - 3. Working Pressure Rating: 500 psig (3450 kPa).
 - 4. Maximum Operating Temperature: 275 deg F (135 deg C).
- O. Receivers: Comply with ARI 495.

- 1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
- 2. Comply with UL 207; listed and labeled by an NRTL.
- 3. Body: Welded steel with corrosion-resistant coating.
- 4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
- 5. End Connections: Socket or threaded.
- 6. Working Pressure Rating: 500 psig (3450 kPa).
- 7. Maximum Operating Temperature: 275 deg F (135 deg C).
- P. 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 (3450 kPa).
 - 4. Maximum Operating Temperature: 275 deg F (135 deg C).

2.04 REFRIGERANTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Atofina Chemicals, Inc.
 - 2. DuPont Company; Fluorochemicals Div.
 - 3. Honeywell, Inc.; Genetron Refrigerants.
 - 4. INEOS Fluor Americas LLC.
- B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

- 3.01 PIPING APPLICATIONS FOR REFRIGERANT R-410A
 - A. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - B. Hot-Gas and Liquid Lines: Copper, Type ACR or L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - C. Hot-Gas and Liquid Lines: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - D. Hot-Gas and Liquid Lines: Copper, Type ACR, K (A) or L (B), drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
 - E. Hot-Gas and Liquid Lines: Copper, Type ACR, K (A) or L (B), drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
 - F. Hot-Gas and Liquid Lines:

- 1. NPS 5/8 (DN 18) and Smaller: Copper, Type ACR or L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- 2. NPS 3/4 to NPS 1 (DN 20 to DN 25) and Smaller: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- 3. NPS 1-1/4 (DN 32) and Smaller: Copper, Type ACR, K (A) or L (B), drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- 4. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): Copper, Type ACR, K (A) or L (B), drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- G. Hot-Gas and Liquid Lines NPS 2 to NPS 4 (DN 50 to DN 100): Schedule 40, blacksteel and wrought-steel fittings with welded joints.
- H. Safety-Relief-Valve Discharge Piping: Copper, Type ACR or L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- I. Safety-Relief-Valve Discharge Piping: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- J. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, K (A) or L (B), drawntemper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- K. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, K (A) or L (B), drawntemper tubing and wrought-copper fittings with Alloy HB soldered joints.
- L. Safety-Relief-Valve Discharge Piping:
 - 1. NPS 5/8 (DN 18) and Smaller: Copper, Type ACR or L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 2. NPS 3/4 to NPS 1 (DN 20 to DN 25) and Smaller: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 3. NPS 1-1/4 (DN 32) and Smaller: Copper, Type ACR, K (A) or L (B), drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
 - 4. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): Copper, Type ACR, K (A) or L (B), drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- M. Safety-Relief-Valve Discharge Piping NPS 2 to NPS 4 (DN 50 to DN 100): Schedule 40, black-steel and wrought-steel fittings with welded joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

- D. Except as otherwise indicated, install 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 and hot-gas bypass 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. Hot-gas bypass valves.
 - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

3.03 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. Refer to Section 23 09 00 "Instrumentation and Control for HVAC" and Section 23 09 93 "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. 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.
- P. 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.
- Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
 - 1. Shot blast the interior of piping.
 - 2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.

- 3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
- 4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
- 5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
- 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
- R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- S. Identify refrigerant piping and valves according to Section 23 05 53 "Identification for HVAC Piping and Equipment."
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."
- 3.04 PIPE JOINT CONSTRUCTION
 - A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
 - D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
 - E. 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.
 - F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

- 1. Apply appropriate tape or thread compound to external pipe threads unless dryseal 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. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.
- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- 3.05 HANGERS AND SUPPORTS
 - A. Hanger, support, and anchor products are specified in Section 23 05 29 "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 (6 m) long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) 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 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
 - 2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
 - 3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
 - 4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).

- 9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
 - 2. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9.5 mm).
 - 3. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (9.5 mm).
 - 4. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).
- E. Support multifloor vertical runs at least at each floor.
- 3.06 FIELD QUALITY CONTROL
 - A. Perform tests and inspections and prepare test reports.
 - B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.07 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 (67 Pa). 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 (14 kPa).
 - 4. Charge system with a new filter-dryer core in charging line.

3.08 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 23 25 13

WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes the following water treatment for closed-loop hydronic systems:
 - 1. Automatic chemical-feed equipment.
 - 2. Chemicals.
- B. Related Requirements:
 - 1. Section 23 25 33 "HVAC Makeup-Water Filtration Equipment" for water softeners, RO equipment, and filtration equipment.

1.03 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- B. RO: Reverse osmosis.
- C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.04 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
 - 1. Bypass feeders.
 - 2. Water meters.
 - 3. Inhibitor injection timers.
 - 4. pH controllers.
 - 5. TSS controllers.
 - 6. Chemical solution tanks.
 - 7. Injection pumps.
 - 8. Chemical test equipment.
 - 9. Chemical material safety data sheets.

- B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For 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.
- B. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- C. Field quality-control reports.
- D. Other Informational Submittals:
 - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
 - 2. Water Analysis: Illustrate water quality available at Project site.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC watertreatment service provider capable of analyzing water qualities, installing watertreatment equipment, and applying water treatment as specified in this Section.

1.08 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
 - 1. Initial water analysis and HVAC water-treatment recommendations.
 - 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
 - 3. Periodic field service and consultation.

- 4. Customer report charts and log sheets.
- 5. Laboratory technical analysis.
- 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Aqua-Chem, Inc.
 - 2. Cascade Water Services, Inc.
 - 3. Earthwise Environmental Inc.
 - 4. General Electric Company; GE Water & Process Technologies.
 - 5. Nalco; an Ecolab company.

2.02 PERFORMANCE REQUIREMENTS

- A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including chilled water, shall have the following water qualities:
 - 1. pH: Maintain a value within 9.0 to 10.5.
 - 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - 3. Boron: Maintain a value within 100 to 200 ppm.
 - 4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
 - 5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
 - 6. TSS: Maintain a maximum value of 10 ppm.
 - 7. Ammonia: Maintain a maximum value of 20 ppm.
 - 8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
 - 9. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
 - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
 - d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
 - e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.03 AUTOMATIC CHEMICAL-FEED EQUIPMENT

- A. Water Meter:
 - 1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
 - 2. Body: Bronze.
 - 3. Minimum Working-Pressure Rating: 150 psig (1035 kPa).
 - 4. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
 - 5. Registration: Gallons (Liters) or cubic feet (cubic meters).
 - 6. End Connections: Threaded.
 - 7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
 - 8. 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. Water Meter:
 - 1. AWWA C701, turbine-type, totalization meter.
 - 2. Body: Bronze.
 - 3. Minimum Working-Pressure Rating: 100 psig (690 kPa).
 - 4. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
 - 5. Registration: Gallons (Liters) or cubic feet (cubic meters).
 - 6. End Connections: Threaded.
 - 7. Control: Low-voltage signal capable of transmitting 1000 feet (305 m).
 - 8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Water Meter:
 - 1. AWWA C701, turbine-type, totalization meter.
 - 2. Body: Epoxy-coated cast iron.
 - 3. Minimum Working-Pressure Rating: 150 psig (1035 kPa).
 - 4. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
 - 5. Registration: Gallons (Liters) or cubic feet (cubic meters).
 - 6. End Connections: Flanged.
 - 7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
 - 8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Chemical Solution Tanks:
 - 1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
 - 2. Molded cover with recess for mounting pump.
 - 3. Capacity: 50 gal. (189 L).
- E. Chemical Solution Injection Pumps:

- 1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
- 2. Adjustable flow rate.
- 3. Metal and thermoplastic construction.
- 4. Built-in relief valve.
- 5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
- 6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.
- G. Injection Assembly:
 - 1. Quill: Minimum NPS 1/2 (DN 15) with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
 - 2. Ball Valve: Three-piece, stainless steel; selected to fit quill.
 - 3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
 - 4. Assembly Pressure/Temperature Rating: Minimum 600 psig (4137 kPa) at 200 deg F (93 deg C).
- 2.04 CHEMICALS
 - A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.
- PART 3 EXECUTION
- 3.01 WATER ANALYSIS
 - A. Perform an analysis of supply water to determine quality of water available at Project site.

3.02 INSTALLATION

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Comply with requirements in Section 23 05 48 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install water testing equipment on wall near water chemical application equipment.
- D. Install interconnecting control wiring for chemical treatment controls and sensors.

- E. Mount sensors and injectors in piping circuits.
- F. Bypass Feeders: Install in closed hydronic systems, including chilled water, and equipped with the following:
 - 1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
 - 2. Install water meter in makeup-water supply.
 - 3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
 - 4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
 - 5. Install a swing check on the inlet after the isolation valve.

3.03 CONNECTIONS

- A. Where installing piping adjacent to equipment, allow space for service and maintenance.
- B. Make piping connections between HVAC water-treatment equipment and dissimilarmetal piping with dielectric fittings. Comply with requirements in Section 23 21 16 "Hydronic Piping Specialties."
- C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 23 05 23 "General-Duty Valves for HVAC Piping."
- D. Comply with requirements in Section 22 11 19 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.
- E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- F. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- 3.04 FIELD QUALITY CONTROL
 - A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.

- 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
- 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
- 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
- 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
- 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
- 7. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
- 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- C. Equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.
- F. Comply with ASTM D 3370 and with the following standards:
 - 1. Silica: ASTM D 859.
 - 2. Acidity and Alkalinity: ASTM D 1067.
 - 3. Iron: ASTM D 1068.
 - 4. Water Hardness: ASTM D 1126.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.
- B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to DSA anchorage notes on sheet M0.01.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Double-wall rectangular ducts and fittings.
 - 3. Single-wall round ducts and fittings.
 - 4. Double-wall round ducts and fittings.
 - 5. Sheet metal materials.
 - 6. Duct liner.
 - 7. Sealants and gaskets.
 - 8. Hangers and supports.
 - 9. Seismic-restraint devices.
 - B. Related Sections:
 - 1. Section 23 07 13 "Duct Insulation"
 - 2. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 3. Section 23 33 00 "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.03 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 ASCE/SEI 7 and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 - 1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.

- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- 1.04 ACTION SUBMITTALS
 - A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
 - 3. Seismic-restraint devices.
 - 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, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Equipment installation based on equipment being used on Project.
 - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 12. Hangers and supports, including methods for duct and building attachment, 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.

1.05 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.
- C. Field quality-control reports.
- 1.06 QUALITY ASSURANCE
 - A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports; AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports; and AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
 - B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code Steel," for hangers and supports.
 - 2. AWS D1.2/D1.2M, "Structural Welding Code Aluminum," for aluminum supports.
 - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
 - C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 "Systems and Equipment" and Section 7 "Construction and System Start-up."
 - D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 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."

2.02 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- 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. McGill AirFlow LLC.
 - 2. Sheet Metal Connectors, Inc.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 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."
- E. 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."
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
 - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - 3. Coat insulation with antimicrobial coating.
 - 4. Cover insulation with polyester film complying with UL 181, Class 1.
- G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
 - Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K) at 75 deg F (24 deg C) mean temperature.

- H. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent or solid sheet steel.
- I. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse 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."
- J. 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."

2.03 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. 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 (1524 mm) in Diameter: Flanged.
- D. 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 (2286 mm) in diameter with buttwelded longitudinal seams.

- 2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-5, "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."
- 2.04 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS
 - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lindab Inc.
 - 2. McGill AirFlow LLC.
 - 3. SEMCO Incorporated.
 - 4. Sheet Metal Connectors, Inc.
 - B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
 - C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
 - 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."
 - a. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.
 - 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."
 - a. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
 - 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-5, "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."

- D. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent, or solid sheet steel.
- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
 - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - 3. Coat insulation with antimicrobial coating.
 - 4. Cover insulation with polyester film complying with UL 181, Class 1.
- F. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
 - Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K) at75 deg F (24 deg C) mean temperature.
- 2.05 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 (Z275).
 - 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 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
 - F. Factory- or Shop-Applied Antimicrobial Coating:

- 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
- 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
- 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
- 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- 5. Shop-Applied Coating Color: Black .
- 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- G. 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.
- H. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.06 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 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:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - 2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. 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."

- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA Inc.
 - b. Armacell LLC.
 - c. Rubatex International, LLC
 - 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 - 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. 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. Insulation Pins and Washers:
 - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
 - 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-(0.41-mm-) thick galvanized steel, aluminum or stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
 - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 - 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 - 3. Butt transverse joints without gaps, and coat joint with adhesive.
 - 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 - 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 - 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).

- 7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
- 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.
- 9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.
- 10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.07 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 6 inches (152 mm).
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 - 10. 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).
 - 11. 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."

- C. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - 6. For indoor applications, 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."
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) 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.

2.08 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 (Table 5-1M), "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.

2.09 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Kinetics Noise Control.
 - 2. Mason Industries.
 - 3. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service, the Office of Statewide Health Planning and Development for the State of California or an agency acceptable to authorities 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 603, galvanized or 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

3.01 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 (25 mm), 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 (38 mm).
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.02 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.
- 3.03 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 (500 Pa) and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): 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 (500 Pa) and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.04 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 (100 mm) thick.
- 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) 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 (Table 5-1M), "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 (610 mm) of each elbow and within 48 inches (1200 mm) 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 (5 m).
- F. Install upper attachments to structures. Select and size upper attachments with pullout, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 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 (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
 - 2. Brace a change of direction longer than 12 feet (3.7 m).
- 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 an evaluation service member of the ICC Evaluation Service, the Office of Statewide Health Planning and Development for the State of California or an agency acceptable to authorities 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.

3.06 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.
- 3.07 PAINTING
 - A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanizedsteel primer. Paint materials and application requirements are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- 3.08 FIELD QUALITY CONTROL
 - A. Perform tests and inspections.
 - B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - b. Supply Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 100 percent of total installed duct area for each designated pressure class.
 - c. Return Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 100 percent of total installed duct area for each designated pressure class.

- d. Exhaust Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 100 percent of total installed duct area for each designated pressure class.
- e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 100 percent of total installed duct area for each designated pressure class.
- 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
- 4. Test for leaks before applying external insulation.
- 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
- 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- 3.09 DUCT CLEANING
 - A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
 - B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct staticpressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
 - C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

- 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
 - 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 - 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 - 6. Provide drainage and cleanup for wash-down procedures.
 - 7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
- 3.11 DUCT SCHEDULE
 - A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

- 1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior or stainless steel.
- B. Supply Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units :
 - a. Pressure Class: Positive 2-inch wg (500 Pa).
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 12
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 - 2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg (750 Pa).
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 - 3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
 - a. Pressure Class: Positive 4-inch wg (1000 Pa).
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 - 4. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 4-inch wg (1000 Pa).
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
- C. Return Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 3-inch wg (750 Pa).
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 - 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 4-inch wg (1000 Pa).

- b. Minimum SMACNA Seal Class: B.
- 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 (750 Pa).
 - b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 3-inch wg (750 Pa).
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 - 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 4-inch wg (1000 Pa).
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 3-inch wg (750 Pa).
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 - 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 4-inch wg (1000 Pa).
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 6.

- d. SMACNA Leakage Class for Round and Flat Oval: 6.
- F. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel, Carbon steel coated with zincchromate primer or Galvanized steel or carbon steel coated with zinc-chromate primer.
 - 2. PVC-Coated Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Galvanized or Match duct material.
 - 3. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Galvanized or Match duct material.
 - 4. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.
- G. Liner:
 - 1. Supply Air Ducts: Flexible elastomeric, 2 inches (51 mm) thick.
 - 2. Return Air Ducts: Flexible elastomeric, 2 inches (51 mm) thick.
 - 3. Supply Fan Plenums: Flexible elastomeric, 2 inches (51 mm) thick.
 - 4. Return- and Exhaust-Fan Plenums: Flexible elastomeric, 2 inches (51 mm) thick.
 - 5. Transfer Ducts: Flexible elastomeric, 2 inches (51 mm) thick.
- H. Double-Wall Duct Interstitial Insulation:
 - 1. Supply Air Ducts: 2 inches (51 mm) thick.
 - 2. Return Air Ducts: 2 inches (51 mm) thick.
 - 3. Exhaust Air Ducts: 1 inch (25 mm) thick.
- I. 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 (5 m/s) 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 (5 to 7.6 m/s):
 - 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 (7.6 m/s) 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."
 - 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 (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm (7.6 m/s) 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 (305 mm) and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Standing seam or Welded.
- J. 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 and Flat Oval: 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 (5 m/s) or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
 - c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Manual-volume dampers.
 - 3. Turning vanes.
 - 4. Flexible ducts.
 - 5. Flexible connectors.
 - 6. Duct accessory hardware.

1.03 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backdraft dampers.
 - 2. Manual-volume dampers.
 - 3. Duct-mounted access doors and panels.
 - 4. Flexible ducts.
 - 5. Turning vanes.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location, and size of each field connection. Detail the following:
 - 1. Special fittings and manual- and automatic-volume-damper installations.
 - 2. Fire- and smoke-damper installations, including sleeves and duct-mounted access doors and panels.
- C. Product Certificates: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static-pressure loss, dimensions, and weights.

1.04 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with the following NFPA standards:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.05 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

- 2.01 SHEET METAL MATERIALS
 - A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.
 - B. Stainless Steel: ASTM A 480/ A 480M
 - C. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
 - D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- 2.02 BACKDRAFT DAMPERS
 - A. Description: Suitable for horizontal or vertical installations.
 - B. Frame: 0.052-inch- thick, galvanized, sheet steel, with welded corners and mounting flange.
 - C. Blades: 0.050-inch- thick aluminum sheet.
 - D. Blade Seals: Neoprene.
 - E. Blade Axles: Galvanized steel.
 - F. Tie Bars and Brackets: Galvanized steel.
 - G. Return Spring: Adjustable tension.
- 2.03 MANUAL-VOLUME DAMPERS
 - A. General: Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
 - 1. Pressure Classifications of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

- B. Low-Leakage Volume Dampers: Multiple- or single-blade, opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
 - 1. Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 - 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized, sheet steel.
 - 3. Blade Seals: Neoprene.
 - 4. Blade Axles: Galvanized steel.
 - 5. Tie Bars and Brackets: Galvanized steel.
- C. Jackshaft: 1-inch- diameter, galvanized steel pipe rotating within a pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 1. Length and Number of Mountings: Appropriate to connect linkage of each damper of a multiple-damper assembly.
- D. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inchthick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.04 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch- wide, double radius curved blades set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into side strips suitable for mounting in ducts.
- C. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.05 FLEXIBLE CONNECTORS

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- B. Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized, sheet.
- C. Transverse Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 4-3/8-inch- wide, 0.028-inch- thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts.

- D. Conventional, Indoor System Flexible Connector Fabric: Glass fabric double coated with polychloroprene.
 - 1. Minimum Weight: 26 oz./sq. yd.
 - 2. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.
- E. Conventional, Outdoor System Flexible Connector Fabric: Glass fabric double coated with a synthetic-rubber, weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.
 - 1. Minimum Weight: 24 oz./sq. yd.
 - 2. Tensile Strength: 530 lbf/inch in the warp, and 440 lbf/inch in the filling.
- F. High-Corrosive-Environment System Flexible Connectors: Glass fabric coated with a chemical-resistant coating.
 - 1. Minimum Weight: 14 oz./sq. yd.
 - 2. Tensile Strength: 450 lbf/inch in the warp, and 340 lbf/inch in the filling.

2.06 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 1.
- B. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing, glass-fiber insulation around a continuous inner liner. Duct insulation shall have an R value of 8.
 - 1. Reinforcement: Steel-wire helix encapsulated in inner liner.
 - 2. Outer Jacket: Glass-reinforced, silver Mylar with a continuous hanging tab, integral fibrous-glass tape, and nylon hanging cord.
 - 3. Inner Liner: Polyethylene film.
- C. Pressure Rating: 6-inch wg positive, 1/2-inch wg negative.

2.07 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 length to suit duct insulation thickness.
- B. Splitter Damper Accessories: Zinc-plated damper blade bracket; 1/4-inch, zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.
- D. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
- B. Install volume dampers in lined duct; avoid damage to and erosion of duct liner.
- C. Provide test holes at fan inlet and outlet and elsewhere as indicated.
- D. Install turning vanes in 90° rectangular elbows.
- E. Install flexible connectors in ducts associated with fans and motorized equipment supported by vibration isolators.

3.02 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION

SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. In-line Centrifugal Fans
- 1.03 PERFORMANCE REQUIREMENTS
 - A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
 - B. Operating Limits: Classify according to AMCA 99.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
- B. 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.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For unit hangars and supports 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. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

- 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
- D. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Roof framing and support members relative to duct penetrations.
 - 2. Ceiling suspension assembly members.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.
- 1.05 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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
 - C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.
- 1.06 COORDINATION
 - A. Coordinate size and location of structural-steel support members.
 - B. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.07 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.01 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
 - 1. Loren Cook Company.
 - 2. Twin City Fan.
 - 3. Greenheck Fan Cooperation
- C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- D. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.
- E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- G. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 - 3. Companion Flanges: For inlet and outlet duct connections.
 - 4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 - 5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.02 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.03 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

- 3.01 INSTALLATION
 - A. Install power ventilators level and plumb.
 - B. Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
 - C. Install units with clearances for service and maintenance.
 - D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- 3.02 CONNECTIONS
 - A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
 - B. Install ducts adjacent to power ventilators to allow service and maintenance.
 - C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- 3.03 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. Verify that shipping, blocking, and bracing are removed.
- 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
- 3. Verify that cleaning and adjusting are complete.
- 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
- 5. Adjust belt tension.
- 6. Adjust damper linkages for proper damper operation.
- 7. Verify lubrication for bearings and other moving parts.
- 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
- 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
- 10. Shut unit down and reconnect automatic temperature-control operators.
- 11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.
- 3.04 ADJUSTING
 - A. Adjust damper linkages for proper damper operation.
 - B. Adjust belt tension.
 - C. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
 - D. Replace fan and motor pulleys as required to achieve design airflow.
 - E. Lubricate bearings.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections include the following:
 - 1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
 - 2. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for balancing diffusers, registers, and grilles.

1.03 DEFINITIONS

- A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.
- B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.
- C. Register: A combination grille and damper assembly over an air opening.

1.04 SUBMITTALS

- A. Product Data: For each model indicated, include the following:
 - 1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
 - 2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
 - 3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
 - 4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.
- B. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.

1.05 QUALITY ASSURANCE

- A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

- 2.01 MANUFACTURED UNITS
 - A. Diffusers, registers, and grilles are scheduled on the design documents.
- 2.02 SOURCE QUALITY CONTROL
 - A. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.
- 3.02 INSTALLATION
 - A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
 - B. Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of the panel. Where architectural features or other items conflict with installation, notify Engineer for a determination of final location.
 - C. Install diffusers, registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire smoke dampers.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.04 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION

SECTION 23 51 23

GAS VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Type "B" double wall vents unless equipment allows Concentric Vents.
- B. Related Requirements:
 - 1. Section 22 34 00 Gas-Fired Domestic Water Heaters
 - 2. Section 23 54 16.13 Gas-Fired Furnaces
 - 3. Section 23 52 16 Condensing Boilers

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.
- B. Shop Drawings: For vents.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Detail fabrication and assembly of hangers and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Sample Warranty: For special warranty.
- 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 D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents.
- B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 LISTED TYPE B VENTS

- A. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B or 550 deg F continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 1/4-inch airspace.
- C. Inner Shell: ASTM B209, ASTM B209M, Type 3105 aluminum.
- D. Outer Jacket: Aluminized steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Wall rain cap designed to exclude minimum 90 percent of rainfall.
 - 2. Termination: Exit cone with drain section incorporated into vent.
 - 3. Termination: Antibackdraft.

PART 3 - EXECUTION

- 3.1 EXAMINATION
 - A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Listed Type B Vents: Vents for certified gas appliances.
- B. Listed Concentric Vents where applicable per equipment manufacturers installation instructions.
- 3.3 INSTALLATION OF LISTED VENTS
 - A. Coordinate installation of equipment supports, and wall penetrations.
 - B. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- C. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- D. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- E. Lap joints in direction of flow.
- 3.4 CLEANING
 - A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION

SECTION 23 52 16

GAS-FIRED BOILER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to DSA anchorage notes on sheet M0.01.
- 1.02 SUMMARY
 - A. Section includes gas-fired, electronic ignition boiler, trim, and accessories for generating hot water.
- 1.03 SUBMITTALS
 - A. Equipment has been purchased by the Owner as indicated on the Equipment Schedule.
 - B. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 - C. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.
- 1.04 INFORMATIONAL SUBMITTALS
 - A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Method of attaching hangers to building structure.
 - 2. Size and location of maintenance access.
 - B. Seismic Qualification Certificates: For fan coil units, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

- C. Field quality-control reports.
- D. Product Certificates:
 - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
- 1.05 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
- 1.06 COORDINATION
 - A. Coordinate layout and installation of furnaces and suspension system components with other trades including components.
- 1.07 WARRANTY
 - A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. Heat Exchanger Damaged by Thermal Shock: 20 year from date of Substantial Completion.
 - b. Heat-Exchanger Corrosion: for 10 year from date of Substantial Completion.

PART 2 - PRODUCTS

- 2.01 GENERAL
 - A. Equipment has been purchased and installed by the Contractor as indicated on the Equipment Schedule.
 - B. Contractor to coordinate equipment per the design documents.
 - C. Install gas piping per Section 23 11 23 as shown on the plumbing drawings.
 - D. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.
 - E. Electrical Connection: Factory wire motors and controls for a single electrical connection.
 - F. Install controls per design documents and per section 23 09 00 Instrumentation and Control for HVAC.

2.02 GAS-FIRED, ELECTRONIC IGNITION BOILERS

- A. Description: Factory-fabricated, -assembled, and tested, gas-fired, electronic ignition hot water heating boiler with glass-lined cast iron headers, copper finned tubing and integral cast iron re-circulating pump.
- 2.03 VENTING KITS
 - A. Refer to manufacturers installation instructions to install vent through side of building with vent cap per Section 23 51 23 Gas Vents.
- PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for boiler, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
 - 1. Final boiler location indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine spaces for all clearances to adjacent equipment for maintenance.
- C. Proceed with installation after coordination drawings have been submitted.

3.02 BOILER INSTALLATION

- A. Equipment Mounting:
 - 1. Install boilers on equipment base.
 - 2. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices, including boiler pump, furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.
- 3.03 CONNECTIONS
 - A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - B. Install piping adjacent to boiler to allow service and maintenance.

- C. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 23 21 16 "Hydronic Piping Specialties."
- D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
- E. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves with drain cooler piping to nearest floor drain.
- G. Boiler Venting:
 - 1. Install flue venting per Section 23 51 23 Gas Vents.
- H. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- 3.04 FIELD QUALITY CONTROL
 - A. Testing Agency: a qualified testing agency to perform tests and inspections.
 - B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
 - D. Boiler will be considered defective if it does not pass tests and inspections.
 - E. Prepare test and inspection reports.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner to adjust, operate, and maintain boilers.

END OF SECTION

SECTION 23 54 16.13

GAS-FIRED FURNACES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Gas-fired, noncondensing furnaces and accessories complete with controls.
 - 2. Air filters.
- 1.03 SUBMITTALS
 - A. Equipment has been purchased by the Owner as indicated on the Equipment Schedule.
 - B. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
 - C. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which furnace and fan coil units will be attached.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of maintenance access.
- B. Seismic Qualification Certificates: For fan coil units, 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. Field quality-control reports.
- D. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each furnace to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Furnace and accessories complete with controls.
 - b. Air filter.
 - c. Refrigeration components.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Disposable Air Filters: Furnish one complete sets.
 - 2. Fan Belts: Furnish one set for each furnace fan.

1.07 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 "Systems and Equipment" and Section 7 "Construction and Startup."
- B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 "Heating, Ventilating, and Air-Conditioning."
- C. Comply with NFPA 70.
- 1.08 WARRANTY
 - A. Special Warranty: Manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:
 - 1. Warranty Period, Commencing on Date of Substantial Completion:
 - a. Furnace Heat Exchanger: 20 years.
 - b. Integrated Ignition and Blower Control Circuit Board: Five years.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Equipment has been purchased by the Owner as indicated on the Equipment Schedule.
- B. Contractor to coordinate with Owner to procure and install the equipment per the design documents. Condensing Unit shall be mounted on concrete pad as designed by structural engineer. Fan Coil Units shall be combined with Gas Furnace sections where applicable and shall be mounted on structural frame by structural engineer.
- C. Install gas piping per Section 231123 as shown on the plumbing drawings.
- D. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.
- E. Electrical Connection: Factory wire motors and controls for a single electrical connection.
- F. Install controls per design documents and per section 230900 Instrumentation and Control for HVAC.
- 2.02 GAS-FIRED FURNACES
 - A. Cabinet: Steel Galvanized.
 - 1. Cabinet interior around heat exchanger shall be factory-installed insulation.
 - 2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
 - 3. Factory paint external cabinets in manufacturer's standard color.
 - 4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - B. Fan: Centrifugal, factory balanced, resilient mounted, belt drive.
 - 1. Fan Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 2. Special Motor Features: Single speed, premium efficiency, as defined in Section 230513 "Common Motor Requirements for HVAC Equipment," and with internal thermal protection and permanent lubrication.
 - 3. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - 4. Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.
 - C. Type of Gas: Natural.
 - D. Heat Exchanger: Aluminized steel.
 - E. Burner:

- 1. Gas Valve: 100 percent safety modulating main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
- 2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.
- F. Gas-Burner Safety Controls:
 - 1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
 - 2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
 - 3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
- G. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; and adjustable fan-on and fan-off timing; terminals for connection to accessories.
- H. Vent Materials: Comply with requirements in Section 235123 "Gas Vents" for Type B metal vents.
- I. Capacities and Characteristics:
 - 1. Airflow Configuration: Upflow.
 - 2. Gas type: Natural.
 - 3. Venting Type: Atmospheric vent.
- 2.03 THERMOSTATS
 - A. Controls shall comply with requirements in ASHRAE/IES 90.1, "Controls."
 - B. Solid-State Thermostat: Unit-mounted, programmable, microprocessor-based.
 - C. Control Wiring:
 - 1. Refer to Section 230900 Instrumentation and Control for HVAC and the control diagrams in the Design Documents.
- 2.04 AIR FILTERS
 - A. Disposable Filters: 1 inch thick fiberglass media with ASHRAE 52.2 MERV rating of 6 or higher in sheet metal frame.
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.

- C. Examine roughing-in for gas piping systems to verify actual locations of piping connections before equipment installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.
- B. Mount Units on structural steel frame. Refer to structural drawings.
 - 1. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.
- C. Controls: Install thermostats at mounting height of 60 inches above floor.

3.03 CONNECTIONS

- A. Gas piping installation requirements are specified in Section 231123 Facility Natural-Gas Piping. Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Vent Connection, Noncondensing, Gas-Fired Furnaces: Connect Type B vents to furnace vent connection and extend outdoors. Type B vents and their installation requirements are specified in Section 235123 "Gas Vents."
 - 1. Slope pipe vent back to furnace or to outside terminal.

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Perform electrical test and visual and mechanical inspection.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
 - 3. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.05 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

- 1. Inspect for physical damage to unit casings.
- 2. Verify that access doors move freely and are weathertight.
- 3. Clean units and inspect for construction debris.
- 4. Verify that all bolts and screws are tight.
- 5. Adjust vibration isolation and flexible connections.
- 6. Verify that controls are connected and operational.
- B. Adjust fan belts to proper alignment and tension.
- C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.
- D. Measure and record airflows.
- E. Verify proper operation of capacity control device.
- F. After startup and performance test, lubricate bearings and adjust belt tension.

3.06 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.07 CLEANING

- A. After completing installation, clean furnaces internally according to manufacturer's written instructions.
- B. Install new filters in each furnace within 14 days after Substantial Completion.
- 3.08 DEMONSTRATION
 - A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units.

END OF SECTION

SECTION 23 73 13

MODULAR OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to DSA anchorage notes on sheet M0.01.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Constant-air-volume, single-zone air-handling units.
- 1.03 PERFORMANCE REQUIREMENTS
 - A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.
 - C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.04 ACTION SUBMITTALS

- A. Product Data: For each air-handling unit indicated.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.

- d. Motor ratings, electrical characteristics, and motor accessories.
- 4. Certified coil-performance ratings with system operating conditions indicated.
- 5. Dampers, including housings, linkages, and operators.
- 6. Filters with performance characteristics.
- B. Delegated-Design Submittal: For vibration isolation and seismic restraints 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. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Mechanical equipment layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.
 - 3. Field measurements.
- B. Seismic Qualification Certificates: For air-handling units, 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. Source quality-control reports.
- D. Field quality-control reports.
- 1.06 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.
- 1.07 MAINTENANCE MATERIAL SUBMITTALS
 - A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Filters: One set(s) for each air-handling unit.
- 2. Gaskets: One set(s) for each access door.
- 3. Fan Belts: One set(s) for each air-handling unit fan.

1.08 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 "Systems and Equipment" and Section 7 "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.
- 1.09 COORDINATION
 - A. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.
- PART 2 PRODUCTS
- 2.01 GENERAL
 - A. Equipment is to be used for demonstration and training purposes and does not require smoke detectors in system.
 - B. Equipment has been purchased by the Owner as indicated on the Equipment Schedule.
 - C. Contractor to coordinate with Owner to procure and install the equipment on structural frame as designed by structural engineer.
 - D. Contractor to provide supply and return air plenums to match openings in unit. Ductwork shall be extended to one foot above floor with volume dampers in openings.
 - E. Condensate Drain Pans:

- 1. Fabricate a secondary drain pan under units with two percent slope in at least two planes to collect overflow condensate from cooling coils (including coil piping connections, coil headers, and return bends) and to direct water toward drain connection.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 2 inches (50 mm) deep.
- F. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
 - 1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 23 05 48 "Vibration and Seismic Controls for HVAC" when air-handling unit frame is anchored to building structure.

2.02 AIR FILTRATION SECTION

- A. General Requirements for Air Filtration Section:
 - 1. Comply with NFPA 90A.
 - 2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
- B. Disposable Panel Filters:
 - 1. Factory-fabricated, viscous-coated, flat-panel type.
 - 2. Thickness: 2 inches (50 mm).
 - 3. Arrestance (ASHRAE 52.1): 80.
 - 4. Merv (ASHRAE 52.2): 5.
 - 5. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
 - 6. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.
- C. Filter Gage:
 - 1. 3-1/2-inch- (90-mm-) diameter, diaphragm-actuated dial in metal case.
 - 2. Vent valves.
 - 3. Black figures on white background.
 - 4. Front recalibration adjustment.
 - 5. 2 percent of full-scale accuracy.
 - 6. Range: 0- to 2.0-inch wg (0 to 500 Pa).
 - 7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch (6mm) aluminum tubing, and 2- or 3-way vent valves.

2.03 DAMPERS

- A. Damper Operators: Comply with requirements in Section 23 09 00 "Instrumentation and Control for HVAC."
- B. Outdoor- and Return-Air Mixing Dampers: Parallel-blade, galvanized-steel or extruded-aluminum dampers mechanically fastened to cadmium-plated steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
- C. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
- D. Combination Filter and Mixing Section:
 - 1. Cabinet support members shall hold 2-inch- (50-mm-) thick, pleated, flat, permanent or throwaway filters.
 - 2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Equipment Mounting:
 - 1. Install air-handling units on structural equipment bases.
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.03 CONNECTIONS

- A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4 (DN 32), ASTM B 88, Type M (ASTM B 88M, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 33 00 "Air Duct Accessories."
- 3.04 FIELD QUALITY CONTROL
 - A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - C. Tests and Inspections:
 - 1. Leak Test: After installation, fill coils with water, and test coils and connections for leaks.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
 - E. Prepare test and inspection reports.
- 3.05 STARTUP SERVICE
 - A. Engage a factory-authorized service representative to perform startup service.

- 1. Complete installation and startup checks according to manufacturer's written instructions.
- 2. Verify that shipping, blocking, and bracing are removed.
- 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
- 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
- 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
- 6. Verify that dampers fully open and close.
- 7. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
- 8. Comb coil fins for parallel orientation.
- 9. Install new, clean filters.
- 10. Verify that manual and automatic volume control.
- B. Starting procedures for air-handling units include the following:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 - 2. Measure and record motor electrical values for voltage and amperage.
 - 3. Manually operate dampers from fully closed to fully open position and record fan performance.
- 3.06 ADJUSTING
 - A. Adjust damper linkages for proper damper operation.
 - B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.07 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.
- 3.08 DEMONSTRATION
 - A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION

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SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.
- 1.03 SUBMITTALS
 - A. Equipment has been purchased by the Owner as indicated on the Equipment Schedule.
 - B. 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.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- 1.04 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) for each air-handling unit.
 - 2. Gaskets: One set(s) for each access door.
 - 3. Fan Belts: One set(s) for each air-handling unit fan.
- 1.06 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."
- 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.
- 1.07 COORDINATION
 - A. Coordinate sizes and locations of equipment supports with actual equipment provided.

1.08 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: Five 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

- 2.01 GENERAL
 - A. Equipment is to be used for demonstration and training purposes.
 - B. Equipment has been purchased by the Owner as indicated on the Equipment Schedule.
 - C. Contractor to coordinate with Owner to procure and install the equipment per the design documents: Condensing Unit shall be mounted on structural frame as designed by structural engineer. Ductless Split Units shall be mounted on wall.
 - D. Install refrigerant piping per manufacturers installation instructions and in accordance with Section 232300 Refrigerant Piping.
 - 1. The (5) ductless split units shall be served by (1) condensing unit.
 - E. Condensate Drain Pan:
 - 1. Fabricate a secondary drain pan under the condensing unit to collect condensate.
 - 2. Route condensate drain to nearest floor sink.

2.02 INDOOR UNITS

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 206/110.
- 3. Fan: Direct drive, centrifugal.
- 4. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 - b. Multi-tapped, 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 exterior of unit.
- 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- 2.03 OUTDOOR UNITS
 - 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 206/110.
 - 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 35 deg F.
 - 7. Mounting Base: Polyethylene.

2.04 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 23 09 00 "Instrumentation and Control for HVAC."

- 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

3.01 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install compressor-condenser components on equipment supports per structural design documents and in accordance with manufacturers installation instructions.
- D. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.02 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.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. 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.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.
- 3.04 STARTUP SERVICE
 - A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
- 3.05 DEMONSTRATION
 - A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 23 82 19

FAN COIL UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY
 - A. Section Includes:
 - 1. Ducted Dx fan coil units, condensing units and accessories.
- 1.03 SUBMITTALS
 - A. Equipment has been purchased by the Owner as indicated on the Equipment Schedule.
 - B. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 - C. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which fan coil units will be attached.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of maintenance access.
 - 4. Refrigerant pipe routing from Fan Coil to Condensing Unit.
- B. Seismic Qualification Certificates: For fan coil units, 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. Field quality-control reports.
- 1.05 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
 - 1. In addition include the maintenance schedules and repair part lists for motors, coils, integral controls, and filters.
- 1.06 QUALITY ASSURANCE
 - A. Comply with NFPA 70.
 - B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 "Systems and Equipment" and Section 7 "Construction and Startup."
 - C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 "Heating, Ventilating, and Air-Conditioning."
- 1.07 COORDINATION
 - A. Coordinate layout and installation of fan coil units and suspension system components with other trades including components.
- 1.08 WARRANTY
 - A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Compressor failure.
 - b. Condenser coil leak.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

- 2.01 GENERAL
 - A. Equipment is to be used for demonstration and training purposes.
 - B. Equipment has been purchased by the Owner as indicated on the Equipment Schedule.

- C. Contractor to coordinate with Owner to procure and install the equipment per the design documents. Condensing Unit shall be mounted on concrete pad as designed by structural engineer. Fan Coil Units shall be combined with Gas Furnace sections where applicable and shall be mounted on structural frame by structural engineer.
- D. Install refrigerant piping per manufacturers installation instructions and in accordance with Section 232300 Refrigerant Piping.
- E. Units combined with gas furnaces shall be installed with gas piping per Section 231123 as shown on the plumbing drawings.
- F. Condensate Drain Piping
 - 1. Route condensate drain to nearest floor sink.
- G. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.
- H. Electrical Connection: Factory wire motors and controls for a single electrical connection.
- I. Install controls per design documents and per section 230900 Instrumentation and Control for HVAC.
- 2.02 DUCTED FAN COIL UNITS
 - A. Ductwork to Fan Coil Units (where applicable) shall be installed per the following Sections:
 - 1. 233113 Metal Ducts
 - 2. 230713 Duct Insulation
 - 3. 233300 Air Duct Accessories.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.02 INSTALLATION
 - A. Install fan coil units' level and plumb.
 - B. Install fan coil units to comply with NFPA 90A.

- C. Install fan coil units on structural frame with elastomeric supports. Vibration isolators are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste.
 - a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.
- B. Connect supply-air to fan coil units with flexible duct connectors specified in Section 23 33 00 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- 3.04 FIELD QUALITY CONTROL
 - A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
 - D. Remove and replace malfunctioning units and retest as specified above.
 - E. Prepare test and inspection reports.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION

SECTION 26 01 00

ELECTRICAL GENERAL PROVISIONS

ARTICLE 1 SUMMARY

- 1.1 This Division of the specification outlines the provisions of the contract work to be performed under this Division.
- 1.2 This Section applies to and forms a part of each section of specifications in Division 26 and all work performed under the electrical and communications contracts.
- 1.3 In addition, work in this Division is governed by the provisions of the bidding requirements, contract forms, general conditions and all sections under general requirements.
- 1.4 These specifications contain statements which may be more definitive or more restrictive than those contained in the General Conditions. Where these statements occur, they shall take precedence over the General Conditions.
- 1.5 Where the words 'provide' or 'provision' are used, it shall be definitely interpreted as 'furnishing and installing complete in operating condition'. Where the words 'as indicated' or 'as shown' are used, it shall mean as shown on contract drawings.
- 1.6 Where items are specified in the singular, this Division shall provide the quantity as shown on drawings plus any spares or extras mentioned on drawings or specifications. All specified and supplied equipment shall be new.
- ARTICLE 2 CONTRACTOR QUALIFICATIONS
 - 2.1 The Contractor shall have a current California C-10 Electrical Contractor's license and all individuals working on this project shall have passed the Department of Industrial Relations Division of apprenticeship Standards "Electrician Certification Program."
- ARTICLE 3 CODES, PERMITS AND FEES
 - 3.1 Comply with all applicable laws, ordinances, rules, regulations, codes, or rulings of governmental units having jurisdiction as well as standards of NFPA, and serving utility requirements.
 - 3.2 Obtain permits, fees, inspections, meter and the like, associated with work in each section of this Division.
 - 3.3 Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Act (OSHA).

ELECTRICAL GENERAL PROVISIONS 26 01 00-1

ARTICLE 4 EXAMINATION OF PREMISES

4.1 Examine the construction drawings and premises prior to bidding. No allowances will be made for not being knowledgeable of existing conditions.

ARTICLE 5 STANDARDS

- 5.1 The following standard publications of the latest editions enforced and supplements thereto shall form a part of these specifications. All electrical work must, as a minimum, be in accordance with these standards.
 - 5.1.1 2016 California Electrical Code (CEC), Part 3 Title 24 CCR.
 - 5.1.2 National Fire Protection Association.
 - 5.1.3 Underwriters' Laboratories, Inc. (UL).
 - 5.1.4 Certified Ballast Manufacturers' Association (CBM).
 - 5.1.5 National Electrical Manufacturers' Association (NEMA).
 - 5.1.6 Institution of Electrical & Electronics Engineers (IEEE).
 - 5.1.7 American Society for Testing & Materials (ASTM).
 - 5.1.8 National Board of Fire Underwriters (NBFU).
 - 5.1.9 National Board of Standards (NBS).
 - 5.1.10 American National Standards Institute (ANSI).
 - 5.1.11 Insulated Power Cable Engineers Association (IPECS).
 - 5.1.12 Electrical Testing Laboratories (ETL).
 - 5.1.13 National Electrical Safety Code (NESC).
 - 5.1.14 2016 California Building Code (CBC), Part 2, Title 24 CCR.
 - 5.1.15 2016 California Fire Code (CFC), Part 9, Title 24, CCR.
 - 5.1.16 2016 NFPA 72 with California State Amendments
 - 5.1.17 National Electrical Testing Association (NETA), 2010 or most current

ARTICLE 6 DEFINITIONS

- 6.1 Concealed: Hidden from sight, as in trenches, chases, hollow construction, or above furred spaces, hung ceilings acoustical or plastic type, or exposed to view only in tunnels, attics, shafts, crawl spaces, unfinished spaces, or other areas solely for maintenance and repair.
- 6.2 Exposed, Non-Concealed, Unfinished Space: A room or space that is ordinarily accessible only to building maintenance personnel, a room noted on the 'finish schedule' with exposed and unpainted construction for walls, floors, or ceilings or specifically mentioned as 'unfinished'.
- 6.3 Finish Space: Any space ordinarily visible, including exterior areas.

ARTICLE 7 WORK AND MATERIALS

- 7.1 Unless otherwise specified, all materials must be new and of the best quality. Materials previously incorporated into other projects, salvaged, or refurbished are not considered new. Perform all labor in a thorough and workmanlike manner.
- 7.2 All materials provided under the contract must bear the UL label where normally available. Note that this requirement may be repeated under equipment specifications. In general, such devices as will void the label should be provided in separate enclosures and wired to the labeled unit in proper manner.

ARTICLE 8 SHOP DRAWINGS AND SUBMITTALS

- 8.1 Submit shop drawings and all data in accordance with Division 1 of these specifications and as noted below for all equipment provided under this Division.
- 8.2 Shop drawings submittals demonstrate to the Architect that the Contractor understands the design concept. The Contractor demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods of material and equipment he intends to use. If deviations, discrepancies, or conflicts between submittals and specifications are discovered either prior to or after submittals are processed, notify the Architect immediately.
- 8.3 Manufacturer's data and dimension sheets shall be submitted giving all pertinent physical and engineering data including weights, cross sections and maintenance instructions. Standard items of equipment such as receptacles, switches, plates, etc., which are cataloged items, shall be listed by manufacturer.
- 8.4 Index all submittals and reference them to these specifications. All submittal items shall be assembled and submitted, one for each specification section. (Multiple specification sections may be grouped together in one common submittal binder, as long as each individual section is clearly identified.) Partial or incomplete submittal sections will not be reviewed.

ARTICLE 9 EQUIPMENT PURCHASES

- 9.1 Arrange for purchase and delivery of all materials and equipment within 20 days after approval of submittals. All materials and equipment must be ordered in ample quantities for delivery at the proper time. If items are not on the project in time to expedite completion, the Owner may purchase said equipment and materials and deduct the cost from the contract sum.
- 9.2 Provide all materials of similar class or service by one manufacturer.

ARTICLE 10 COOPERATIVE WORK

10.1 Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration.

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10.2 Cooperative work includes: General supervision and responsibility for proper location and size of work related to this Division, but provided under the other sections of these specifications, and installation of sleeves, inserts, and anchor bolts for work under each section in this Division.

ARTICLE 11 VERIFICATION OF DIMENSIONS

- 11.1 Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions, etc., and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.
- 11.2 Drawings are essentially diagrammatic, and many offsets, bends, pull boxes, special fittings, and exact locations are not indicated. Carefully study drawings and premises in order to determine best methods, exact location, routes, building obstructions, etc. and install apparatus and equipment in manner and locations to avoid obstructions, preserve headroom, keep openings and passageways clear, and maintain proper clearances.

ARTICLE 12 CUTTING AND PATCHING

- 12.1 All cutting and patching shall be in accordance with Division 1 of these specifications and as noted below.
- 12.2 Cut existing work and patch as necessary to properly install new work. As the work progresses, leave necessary openings, holes, chases, etc., in their correct location. If the required openings, holes, chases, etc., are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members including wall framing without the consent of the Architect.
- ARTICLE 13 CLOSING-IN OF UNINSPECTED WORK
 - 13.1 Cover no work until inspected, tested, and approved by the Architect. Where work is covered before inspection and test, uncover it and when inspected, tested, and approved, restore all work to original proper condition at no additional cost to Owner.

ARTICLE 14 EXCAVATION AND BACKFILL

- 14.1 All excavation and backfill shall be in accordance with Division 1 of these specifications and as noted below.
- 14.2 Perform all necessary excavation, shoring, and backfilling required for the proper laying of all conduits inside the building and premises, and outside as may be necessary.

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- 14.3 Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms no wider than necessary to provide ample work room. Grade trench bottoms accurately. Machine grade only to the top line of the conduits, doing the remainder by hand. Do not cut any trench near or under footings without first consulting the Architect. All trenches shall be done in accordance with OSHA standards and regulations.
- 14.4 Backfilling shall be done with each layer compacted before another layer is added. No stones or coarse lumps shall be laid directly on a conduit or conduits.
- 14.5 Trenches shall be filled with the specified material. Sod, if any, shall be removed in cut sections and replaced in same manners.
- 14.6 Provide pumps and drainage of all open trenches for purposes of installing electrical duct and wiring.
- 14.7 Perform all backfilling in accordance with the requirements of and under the direction of the Geotechnical Engineer.
- 14.8 Where new underground trenching is required on sites or in any area where existing underground utilities exist, the Contractor shall provide an independent professional utility locating service to locate exact vertical and horizontal locations of all existing utilities. Where existing utilities are found the Contractor shall hand dig the areas to avoid disruption. The Contractor shall be responsible for immediate repairs to existing underground utilities damaged during construction. The Contractor shall repair all existing asphalt, concrete and landscape surfaces damaged or removed during construction to match their original conditions. Where trenching extends through public streets or roadways, the Contractor shall notify underground service alert in addition to the independent locating service 48 hours before start of construction to determine location of existing utilities by calling (800) 422-4133.

ARTICLE 15 CONCRETE

- 15.1 Where used for structures to be provided under the contract such as bases, etc., concrete work, and associated reinforcing shall be as specified under Division 3 of these specifications.
- 15.2 See other sections for additional requirements for underground vaults, cable ducts, etc.

ARTICLE 16 ACCESSIBILITY

16.1 Install all control devices or other specialties requiring reading, adjustment, inspection, repairs, removal, or replacement conveniently and accessibly throughout the finished building.

- 16.2 All required access doors or panels in walls and ceilings are to be furnished and installed as part of the work under this Section. Refer to Division 1 of these specifications and as noted below.
- 16.3 Where located in fire rated assemblies, provide doors which match the rating of the assembly and are approved by the jurisdictional authority.
- 16.4 Refer to 'finish schedule' for types of walls and ceilings in each area and the architectural drawings for rated wall construction.
- 16.5 Coordinate work of the various sections to locate specialties requiring accessibility with others to avoid unnecessary duplication of access doors.
- ARTICLE 17 FLASHING
 - 17.1 Flash and counter flash all conduits penetrating roofing membrane as shown on Architectural drawings. All work shall be in accordance with Division 7 of these specifications.

ARTICLE 18 IDENTIFICATION OF EQUIPMENT

- 18.1 All electrical equipment shall be labeled, tagged, stamped, or otherwise identified in accordance with the following schedules:
 - 18.1.1 General:
 - 18.1.1.1 In general, the installed laminated nameplates as hereinafter called for shall also clearly indicate its use, areas served, circuit identification, voltage and any other useful data.
 - 18.1.1.2 All auxiliary systems, including communications, shall be labeled to indicate function.
 - 18.1.2 Lighting and Local Panelboards:
 - 18.1.2.1 Panel identification shall be with white and black micarta nameplates. Letters shall be no less than 3/8" high.
 - 18.1.2.2 Circuit directory shall be two column typewritten card set under glass or glass equivalent. Each circuit shall be identified by the room number and/or number of unit and other pertinent data as required.
 - 18.1.3 Distribution Switchboards and Feeders Sections:
 - 18.1.3.1 Identification shall be with 1" x 4" laminated white micarta nameplates with black lettering on each major component, each with name and/or number of unit and other pertinent data as required. Letters shall be no less than 3/8" high.

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- 18.1.3.2 Circuit breakers and switches shall be identified by number and name with 3/8" x 1-1/2" laminated micarta nameplates with 3/16" high letters mounted adjacent to or on circuit breaker or switch.
- 18.1.4 Disconnect Switches, Motor Starters and Transformers:
 - 18.1.4.1 Identification shall be with white micarta laminated labels and 3/8" high black lettering.
- 18.1.5 All communication system terminal boxes including T.V., telephone/intercom, security, fire alarm, clock, and computer networking shall be provided with white micarta laminated labels and 3/8" high black lettering.

ARTICLE 19 CONSTRUCTION FACILITIES

- 19.1 Furnish and maintain from the beginning to the completion all lawful and necessary guards, railings, fences, canopies, lights, warning signs, etc. Take all necessary precautions required by City, State Laws, and OSHA to avoid injury or damage to any persons and property.
- 19.2 Temporary power and lighting for construction purposes shall be provided under this Section. All work shall be in accordance with Division 1 of these specifications.

ARTICLE 20 GUARANTEE

20.1 Guarantee all material, equipment and workmanship for all sections under this Division in writing to be free from defect of material and workmanship for one year from date of final acceptance, as outlined in the general conditions. Replace without charge any material or equipment proven defective during this period. The guarantee shall include performance of equipment under all site conditions, conditions of load, installing any additional items of control and/or protective devices, as required.

ARTICLE 21 PATENTS

- 21.1 Refer to the General Conditions for Contractor's responsibilities regarding patents.
- ARTICLE 22 PLUMBING (DIVISION 22) / HEATING, VENTILATING, AND AIR CONDTIONING (DIVISION 23) / ELECTRICAL – COORDINATION REQUIREMENTS
 - 22.1 All electrical work performed for this project shall conform to the California Electrical Code, to Local Building Codes and in conformance with Division 22, 23, and 26 of these specifications, whether the work is provided under the "Plumbing", "Heating, Ventilating, and Air Conditioning", or the "Electrical"

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Division of these specifications. Where the Division 22 and/or Division 23 Contractor is required to provide electrical work, he shall arrange for the work to be done by a licensed Division 26 Contractor, using qualified electricians. The Division 22 and/or Division 23 Contractor shall be solely and completely responsible for the correct functioning of all equipment regardless of who provided the electrical work.

- 22.2 The work under Division 22 and/or Division 23 shall include the following:
 - 22.2.1 All motors required by mechanical equipment.
 - 22.2.2 All starters for mechanical equipment which are not provided under the electrical division as part of a motor control center or otherwise indicated on the electrical drawings.
 - 22.2.3 All wiring interior to packaged equipment furnished as an integral part of the equipment.
 - 22.2.4 All control **wiring and conduit** for mechanical control systems.
 - 22.2.5 All control systems required by mechanical equipment.
- 22.3 The work under Division 26 shall include the following:
 - 22.3.1 All power wiring and conduit; and conduit only for EMS control conductors between each building and the main control panel.
 - 22.3.2 Electrical disconnects as shown on the electrical drawings.
 - 22.3.3 Starters forming part of a motor control center.
- 22.4 All power wiring and conduit to equipment furnished under Division 22 and/or Division 23 shall be provided under Division 26. Control wiring and conduit, whether line voltage or low voltage, shall be provided under the division which furnishes the equipment.
- 22.5 Power wiring shall be defined as all wiring between the panelboard switchboard overcurrent device, motor control center starter or switch, and the safety disconnect switch or control panel serving the equipment. Also, the power wiring between safety disconnect switch and the equipment line terminals.
- 22.6 Control wiring shall be defined as all wiring, either line voltage or low voltage, required for the control and interlocking of equipment, including but not limited to wiring to motor control stations, solenoid valves, pressure switches, limit switches, flow switches, thermostats, humidistats, safety devices, smoke detectors, and other components required for the proper operation of the equipment.

- 22.7 All motor starters which are not part of motor control centers and which are required for equipment furnished under this Division shall be furnished and installed by the Division furnishing the equipment and power wiring connected under Division 26. Motor starters and control devices in motor control centers shall be furnished and installed under Division 26.
- 22.8 Division 26 Contractor shall make all final connections of power wiring to equipment furnished under this Division.
- 22.9 Wiring diagrams complete with all connection details shall be furnished under each respective Section.
- 22.10 Motor starters supplied by Plumbing and/or Heating, Ventilating and Air Conditioning shall be fused combination type minimum NEMA Size 1, and conform to appropriate NEMA standards for the service required. Provide NEMA type 3R/12 gasketed enclosures in wet locations. Provide all starters with appropriately sized overload protection and heater strips provided in each phase, hand/off auto switches, a minimum of 2 NO and NC auxiliary contacts as required, and an integral disconnecting means. For ½ horsepower motors and below, when control requirements do not dictate the use of a starter, a manual motor starter switch with overload protection in each phase may be provided. Acceptable manufacturers are Allen Bradley, General Electric, Square D, Furnas and Cutler Hammer.
- ARTICLE 23 EQUIPMENT ROUGH-IN
 - 23.1 Rough-in all equipment, fixtures, etc. as designed on the drawings and as specified herein. The drawings indicate only the approximate location of roughins. Mounting heights of all switches, receptacles, wall mounted fixtures and such equipment must be coordinated with the Architectural Designs. The Contractor shall obtain all rough-in information before progressing with any work for rough-in connections. Minor changes in the contract drawings shall be anticipated and provided for under this Division of the specifications to comply with rough-in requirements.

ARTICLE 24 OWNER FURNISHED AND OTHER EQUIPMENT

24.1 Rough-in and make final connections to all Owner furnished equipment shown on the drawings and specified, and all equipment furnished under other sections of the specifications.

ARTICLE 25 EQUIPMENT FINAL CONNECTIONS

- 25.1 Provide all final connections for the following:
 - 25.1.1 All equipment furnished under this Division.
 - 25.1.2 Electrical equipment furnished under other sections of the specification.
 - 25.1.3 Owner furnished equipment as specified under this Division.

ARTICLE 26 INSERTS, ANCHORS, AND MOUNTING SLEEVES

- 26.1 Inserts and anchors must be:
 - 26.1.1 Furnished and installed for support of work under this Division.
 - 26.1.2 Mounting of equipment that is of such size as to be free standing and that equipment which cannot conveniently be located on walls, such as motor starters, etc., shall be rigidly supported on a framework of galvanized steel angle of Unistrut or B-line systems with all unfinished edges painted.
 - 26.1.3 Furnish and install all sleeves as required for the installation of all work under all Sections of this Division and for all communication systems including any communication systems described in this Section which are bid to the General Contractor. Sleeves through floors, roof, and walls shall be as described in "Conduit and Fittings" Section 26 05 33.

ARTICLE 27 SEISMIC ANCHORING

- 27.1 Refer to the MEP Component Anchorage and Piping, Ductwork and Electrical Distribution System Bracing notes on the drawings.
 - 27.1.1 All switchgear and other free standing electrical equipment or enclosures shall be anchored to the floor and braced at the top of the equipment to the structure. Where details have not been provided on the drawings, anchorage shall comply with CBC Section 1616A.1.12. The Contractor shall submit drawings signed by the Contractors registered structural Engineer indicating method of compliance prior installation.
 - 27.1.2 All sound systems, communication, signal or data networking equipment or enclosures shall be anchored to the structure. Where details have not been provided on the drawings, anchorage shall comply with CBC Section 1616A.1.12. The Contractor shall submit drawings signed by the Contractors registered Structural Engineer indicating method of compliance prior to installation.

ARTICLE 28 RUST PROOFING

- 28.1 Rust proofing must be applied to all ferrous metals and shall be in accordance with Section 05500 of these specifications and as noted below.
 - 28.1.1 Hot-dipped galvanized shall be applied and after forming of angle-iron, bolts, anchors, etc.
 - 28.1.2 Hot-dipped galvanized coating shall be applied after fabrication for junction boxes and pull boxes cast in concrete.

ARTICLE 29 GENERAL WIRING

- 29.1 Where located adjacent in walls, outlet boxes shall not be placed back to back, nor shall extension rings be used in place of double boxes, all to limit sound transmission between rooms. Provide short horizontal nipple between adjacent outlet boxes, which shall have depth sufficient to maintain wall coverage in rear by masonry wall.
- 29.2 In those instances where outlet boxes, recessed terminal boxes, or recessed equipment enclosures are installed in a fire rated assembly, provide "Flamesafe FSD 1077" fire stopping pads or approved equal, over the outlet or box.
- 29.3 Complete rough-in requirements of all equipment to be wired under the contract are not indicated. Coordinate with respective trades furnishing equipment or with the Architect as the case may be for complete and accurate requirements to result in a neat, workmanlike installation.

ARTICLE 30 SEPARATE CONDUIT SYSTEMS

- 30.1 Each electrical and signal system shall be contained in a separate conduit system as shown on the drawings and as specified herein. This includes each power system, each lighting system, each signal system of whatever nature, telephone, standby system, sound system, control system, fire alarm system, etc.
- 30.2 Further, each item of building equipment must have its own run of power wiring. Control wiring may be included in properly sized conduit for equipment feeders of #6 AWG and smaller, having separate conduit for larger sizes.

ARTICLE 31 CLEANUP

- 31.1 In addition to cleanup specified under other sections, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any spattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.
- 31.2 Use steel brushes on exposed metal work to carefully remove rust, etc., and leave smooth and clean.
- 31.3 During the progress of the work, keep the premises clean and free of debris.

ARTICLE 32 UTILITY SERVICES

32.1 Contractor shall notify underground service alert 48 hours before start of construction to determine location of existing utilities by calling (800) 422-4133. All work shall be in accordance with the Division 1 Sections of these specifications.

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ARTICLE 33 PAINTING

33.1 Paint all unfinished metal as required in accordance with Division 1 of these specifications. (Galvanized and factory painted equipment shall be considered as having a sub-base finish.)

ARTICLE 34 GENERAL DEMOLITION REQUIREMENTS

- 34.1 Remove existing work and items which are required to be removed in such manner that minimum damage and disturbance is caused to adjacent and connection work scheduled to remain. Repair or replace existing work schedule.
- 34.2 Include preparation of existing areas to receive new materials and removal of materials and equipment to alter or repair the existing building as indicated and as specified.
- 34.3 Perform demolition exercising proper care to prevent injury to the public, workmen and adjoining property.
- 34.4 Perform the removal, cutting, drilling of existing work with extreme care and use small tools in order not to jeopardize the structural integrity of the building.
- 34.5 Rebuild to existing condition or better, existing work which has to be removed to allow the installation of new work as required.
- 34.6 Remove, protect and reinstall existing items as indicated. Replace materials scheduled for reuse which are damaged by the Contractor to the extent that they cannot be reused, with equal quality material, and installation.
- 34.7 Do not reuse in this project materials and items removed from existing site or building, except with specific written approval by the Architect in each case, unless such removed material or item is specifically indicated or specified to be reused.
- 34.8 Remove materials and equipment indicated to be salvaged for reinstallation and store to prevent damage, and reinstall as the work progresses. Do not reuse in this project, other materials and equipment removed from existing site or building, except with specific written approval by the Architect in each case.
- 34.9 Patch areas requiring patching, including damage caused by removing, relocating or adding fixtures and equipment, damages caused by demolition at adjacent materials.

- 34.10 Do not stockpile debris in the existing building, without the approval of the Architect. Remove debris as it accumulates from removal operations to a legal disposal area.
- 34.11 Contractor to assume existing oil filled and dry transformers, oil switches, ballasts, lamps, wooden poles, cross arms, computers, computer monitors, and conductor insulation containing materials considered hazardous. Comply with local, state and federal regulations, laws, and ordinances concerning removal, handling and protection against exposure or environmental pollution. Contractor shall be responsible for removal of the above hazardous materials where encountered. Include all costs for such removal as part of this contract.
- 34.12 All fluorescent, compact fluorescent, high intensity discharge, metal halide, mercury vapor, high and low pressure sodium, and neon lamps are to be disposed of as required by the California Waste Rule Regulations as described in the California Code of Regulations, Title 22, Division 4.5 and Chapter 23.
- 34.13 **Communication System:** Where new communication systems, (including telephone, intercom, clock, security, fire alarm, data, multimedia, CATV or lighting controls) are installed to replace existing systems, unless where otherwise directed the existing systems shall remain fully operational until the new system has been installed and tested. Demolition of the existing systems shall include removal of all equipment and associated wiring and exposed conduits and providing new blank covers for all abandoned device locations.
- 34.14 **Salvage Power Equipment:** The Contractor shall carefully remove all existing switchboards, panelboards, transformers, and confirm in writing which items the Owner wishes to keep. These items shall be transported to the Owner's maintenance facilities by the Contractor. All remaining items shall be disposed of by the Contractor.
- 34.15 **Salvage Lighting Equipment:** The Contractor shall confirm in writing which items the Owner wishes to keep. These items shall be transported to the Owner's maintenance facilities by the Contractor. All remaining items shall be disposed of by the Contractor.
- 34.16 **Salvage Communication Equipment:** The Contractor shall carefully remove all communication devices (telephone, intercom, clock, security, fire alarm, data, multimedia, CATV or lighting controls) and box each type of devices separately. The Contractor shall deliver all items to the Owner's maintenance facility.

ARTICLE 35 PROJECT CLOSEOUT

- 35.1 Prior to completion of project, compile a complete equipment maintenance manual for all equipment supplied under sections of this Division, in accordance with Division 1 of these specifications and as described below.
- 35.2 Equipment Lists and Maintenance Manuals:

- 35.2.1 Prior to completion of job, Contractor shall compile a complete equipment list and maintenance manuals. The equipment list shall include the following items for every piece of material equipment supplied under this Section of the specifications:
 - 35.2.1.1 Name, model, and manufacturer.
 - 35.2.1.2 Complete parts drawings and lists.
 - 35.2.1.3 Local supply for parts and replacement and telephone number.
 - 35.2.1.4 All tags, inspection slips, instruction packages, etc., removed from equipment as shipped from the factory, properly identified as to the piece of equipment it was taken from.
- 35.3 Maintenance manuals shall be furnished for each applicable section of the specifications and shall be suitably bound with hard covers and shall include all available manufacturers' operating and maintenance instructions, together with "as-built" drawings to properly operate and maintain the equipment. The equipment lists and maintenance manuals shall be submitted in duplicate to the Architect for approval not less than 10 days prior to the completion of the job. The maintenance manuals shall also include the name, address, and phone numbers of all subcontractors involved in any of the work specified herein. Four copies of the maintenance manuals bound in single volumes shall be provided.

ARTICLE 36 RECORD DRAWINGS

- 36.1 The Division 26 Contractor shall maintain record drawings as specified in accordance with Division 1 of these specifications, and as noted below.
- 36.2 Drawings shall show locations of all concealed underground conduit runs, giving the number and size of conduit and wires. Underground ducts shall be shown with cross section elevations and shall be dimensioned in relation to permanent structures to indicate their exact location. Drawing changes shall not be identified only with referencing CORs and RFIs, the drawings shall reflect all of the actual additions or changes made. All as-built drawing information shall be prepared by the contractor in AutoCAD, updating the contract computer files as needed to reflect actual installed conditions for all site plans, lighting, power, communication, networking, audio visual, and security or fire alarms systems included in the scope of work for this project.
- 36.3 One set of these record drawings shall be delivered to the Architect. The engineer will review documents for completeness, and will not be responsible for editing contractor computer files.

ARTICLE 37 CHANGES AND EXTRA WORK

- 37.1 When **changes** in work are requested, the Division 26 Contractor shall provide unit prices for the work involved in accordance with Division 1 of these specifications, and the following:
 - 37.1.1 The material Costs shall **not exceed** the latest edition of the "Trade Service" end column "C" price list. The materials prices may be higher only where the Contractor can produce invoices to substantiate higher material costs. The Contractor shall submit a print out copy of the trade service sheets with the change order to substantiate these values.
 - 37.1.2 The labor Costs shall <u>not exceed</u> the latest edition of the "NECA Manual of Labor Units" <u>normal column</u>.
- 37.2 When **credits** in work are requested, the Division 26 Contractor shall provide unit prices for the work involved in accordance with Division 1 of these specifications, and the following:
 - 37.2.1 The Material Costs shall <u>not be less than 80% of</u> the latest edition of the "Trade Service" end column price list. The materials prices may be lower only where the Contractor can produce invoices to substantiate lower material costs. Restocking fees may also be included in this amount where applicable.
 - 37.2.2 The Labor Costs shall <u>not be less than 80% of</u> the latest edition of the "NECA Manual of Labor Units" <u>normal column</u>.
- 37.3 Conduit pricing for conduits of all types sized 3" or smaller.

When changes in the scope of work require the Contractor to estimate conduit Installations, they shall **NOT include labor values (only material cost may be included)** for any of the below items. The labor values for conduit installation represented in the NECA manual are inflated to a point where additional labor for the below items can not be justified.

- 37.3.1 Couplings.
- 37.3.2 Set Screw or Compression Fittings, locknuts, Bushings and washers.
- 37.3.3 Conduit straps and associated screws or nails.
- 37.3.4 LB fittings or other specialty fittings or specialty mounting hardware may be included where needed.
- 37.4 Wire pricing for all types and sizes.

When changes in the scope of work require the Contractor to estimate wire installations they shall **NOT include labor values (only material cost may be included)** for any of the below items. The labor values for wire installation

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represented in the NECA manual are inflated to a point where additional labor for the below items can not be justified.

37.4.1 Locknuts, Bushings, tape, wire markers.

37.5 When changes in the scope of work require other equipment installations such as lighting fixtures, panelboards, switchboards, wiring devices, communications equipment etc. the Contractor shall **NOT include labor values (only material cost may be included)** for any of the below items. The labor values for these equipment items represented in the NECA manual are inflated to a point where additional labor for the below items can not be justified.

37.5.1 Associated screws, nails, bolts, anchors or supports.

37.5.2 Locknuts, washers, tape.

37.6 The total labor hours for extra work will be required to be calculated as follows:

37.6.1 Change orders with 1 to 30 total labor hours

General Laborer	10%	of total labor hours
Journeyman	10%	of total labor hours
Foreman	80%	of total labor hours

37.6.2 Change orders with 31 to 100 total labor hours

General Laborer	20%	of total labor hours
Journeyman	40%	of total labor hours
Foreman	40%	of total labor hours

37.6.3 Change orders with over 100 total labor hours

General Laborer	30%	of total labor hours
Journeyman	50%	of total labor hours
Foreman	20%	of total labor hours

- 37.7 When change orders are issued which allow the work to be completed in the normal sequence of construction, the labor rates shall be based on the most current "Prevailing Wage" straight time total hourly rate. When change orders require the Contractor to work out of sequence the "Prevailing Wage" daily overtime hourly rate shall apply. Special condition situations shall be reviewed on an individual basis for alternate hourly rate schedules.
- 37.8 Costs <u>will not</u> be permitted for additional supervision on site or office time for processing any change order other than the 10% overhead allowance as described in Division 1. Cost for special equipment required to install items for an individual change order are permitted and must be individually identified. Lump Sum cost for small tools or any other cost not specifically required for the change order are <u>not</u> permitted.

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- 37.9 Contractor estimates shall be formatted to clearly identify each of the following:
 - 37.9.1 Line item description of each type of material or labor item.
 - 37.9.2 Description of quantity for each item.
 - 37.9.3 Description of (material cost per / quantity).
 - 37.9.4 Description of (labor cost per / quantity).
 - 37.9.5 Description of total labor hour breakdown per Foreman, Journeyman or General Laborer as described above.
- ARTICLE 38 ELECTRONIC FILES
 - 38.1 The Contractor shall make a <u>written</u> request directly to Johnson Consulting Engineers for electronic drawing files. As a part of the written request, please include the following information:
 - 38.1.1 Clearly indicate each drawing sheet needed (i.e., E1.1, E2.1, etc.).
 - 38.1.2 Identify the name, phone number, mailing address and e-mail address of the person to receive the files.
 - 38.1.3 Provide written confirmation and agreement with the requirements described for payment of computer files, as described below.
 - 38.2 Detail or riser diagram sheets, or any other drawings other than floor plans or site plans, *will not be made available to the Contractor*.
 - 38.3 Files will only be provided in the AutoCAD format in which they were created.
 - 38.4 Requests for files will be processed as soon as possible; a minimum of 7 working days should be the normal processing time. The Contractor shall be completely responsible for requesting the files in time for their use.
 - 38.5 CAD files will be made available via e-mail or on disk, depending on the quantity of files requested. The Contractor requesting the files will be required to pay \$50.00 per drawing plan, or \$300.00 maximum, whichever is <u>less</u>.

END OF SECTION

SECTION 26 05 19

POWER CONDUCTORS

PART 1 – GENERAL

- 1.1 Furnish and install wire and cable for branch circuits and feeders specified herein and as shown on the electrical drawings.
- 1.2 Submittals: Submit manufacturers' data for the following items:
 - 1.2.1 All cables and terminations

1.3 <u>Common submittal mistakes which will result in the submittals being</u> rejected:

- 1.3.1 Not including all items listed in the above itemized description.
- 1.3.2 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining, or clouding the items to be reviewed, or crossing out the items which are not applicable.
- 1.3.3 Not including actual manufacturer's catalog information of proposed products.
- 1.3.4 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements, or "to be determined later" statements. The products being submitted must be the products installed

PART 2 – PRODUCTS

- 2.1 Wire and cable Rated 120 volt to 600 volt.
 - 2.1.1 All wire and cable shall be new, 600 volt insulated copper, of types specified below for each application. All wire and cable shall bear the UL label and shall be brought to the job in unbroken packages. Wire insulation shall be the color as specified herein and shall be type THWN-2. Insulated conductors shall be installed in all exterior exposed raceways. Conductors for branch circuit lighting, receptacle, power and miscellaneous systems shall be a minimum of No. 12 AWG. Increase conductor size to No. 10 AWG for 120 volt circuits greater than 100 feet from the panel to the load and for 277 volt circuits greater than 200 feet from the panel to the load. Circuit home-runs indicated to be larger than No. 12 must be increased the entire length of the circuit, including equipment grounding conductor. Wire sizes No. 14 through No. 10 shall be solid. No. 8 and larger shall be stranded.
 - 2.1.2 Aluminum conductors will be permitted (only where specifically identified on the drawings. See "600 Volt Feeder Schedule") in sizes 2/0 or larger. Conductors shall be listed by Underwriters Laboratories (UL) and suitable

for operation at 600 volts or less, at a maximum operating temperature of 90N C maximum in wet or dry locations. Conductors shall be marked "SUN-RES". Aluminum alloy conductors shall be compact stranded conductors of STABILOY® (AA-8030) as manufactured by Alcan Cable or Listed equal. AA-8000 Series aluminum alloy conductor material shall be recognized by The Aluminum Association.

- 2.1.3 MC type armored cable reference Section 26 05 33.
- 2.2 Wire and cable for systems below120 volts.
 - 2.2.1 All low voltage and communications systems cables routed underground shall be provided with a moisture resistant outer jacket, West Penn "Aquaseal" or equal, unless otherwise specified.

PART 3 - EXECUTION

- 3.1 Wire and cable shall be pulled into conduits without strain using powdered soapstone, mineralac, or other approved lubricant. In no case shall wire be repulled if same has been pulled out of a conduit run for any purpose. No conductor shall be pulled into conduit until conduit system is complete, including junction boxes, pull boxes, etc.
- 3.2 All connections of wires shall be made as noted below:
 - 3.2.1 Connections to outlets and switches: Wire formed around binding post of screw.
 - 3.2.2 No. 10 wire and smaller: Circuit wiring connections to lighting fixtures and other hard wired equipment shall be made with pressure type solderless connectors, Buchanan, Scotchlock, Wing Nut, or approved equal. Alternate "WAGO" #773 series or "IDEAL" #32, 33, 34 and 39 series push wire style connectors are also acceptable.
- 3.3 All wiring shall be continuous without splicing unless where specifically noted on the drawings or where permitted below.
 - 3.3.1 No. 10 wire and smaller above grade: Quantities as needed, connection made with pressure type solderless connectors, Scotchlock or equal.
 - 3.3.2 No. 10 wire and smaller below grade: Quantities as needed, connection made with 'Raychem' long barrel compression terminals with crimping tool and quantity of crimps as recommended by manufacturer, provide 'Raychem' WCSM-S series in-line heat shrink, sealant coated splice kit. Alternate products must be UL listed for direct burial/submersible and rated to (1000V).
 - 3.3.3 No. 8 wire and larger above grade: Quantities <u>only</u> where indicated, 'Raychem' long barrel compression terminals with crimping tool and quantity of crimps as recommended by manufacturer, provide 'Raychem'

WCSM-S series in-line heat shrink, sealant coated splice kit. Alternate products must be UL listed for direct burial/submersible and rated to (1000V).

- 3.3.4 No. 8 wire and larger below grade: Quantities <u>only</u> where indicated, 'Raychem' long barrel compression terminals with crimping tool and quantity of crimps as recommended by manufacturer, provide 'Raychem' WCSM-S series in-line heat shrink, sealant coated splice kit. Alternate products must be UL listed for direct burial/submersible and rated to (1000V).
- 3.4 All wiring throughout shall be color coded as follows:

<u>480 volt system</u>		208 or 240 volt system	
A Phase	Brown	Black	
B Phase	Orange	Red	
C Phase	Yellow	Blue	
Neutral	Grey	White	
Ground	Green	Green	

- 3.5 Wiring must be color coded throughout its entire length, except feeders may have color coded plastic tape at both ends and any other accessible point.
- 3.6 All control wiring in a circuit shall be color coded, each phase leg having a separate color, and with all segments of the control circuit, whether in apparatus or conduit, utilizing the same color coding.
- 3.7 At all terminations of control wiring, the wiring shall have a numbered T&B or Brady plastic wire marker.
- 3.8 Cables when installed are to be properly trained in junction boxes, etc., and in such a manner as to prevent any forces on the cable which might damage the cable.
- 3.9 All conductors to be installed into a common raceway, shall be pulled into the raceway at the same time.
- 3.10 All conductors shall be installed in such a manner as to not exceed the manufacturers' recommended pulling tension and bending radius. The equipment used for pulling must be specifically designed for the purpose. Motorized vehicles such as pickup trucks, are not acceptable.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 – GENERAL

- 1.1 Furnish and install grounding and grounding conductors and electrodes as specified herein and as shown on the drawings.
- 1.2 Submit catalog data for all components.

1.3 Common submittal mistakes which will result in the submittals being rejected:

- 1.3.1 Not including all items listed in the above itemized description.
- 1.3.2 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.
- 1.3.3 Not including actual manufacturer's catalog information of proposed products.
- 1.3.4 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements, or "to be determined later" statements. The products being submitted must be the products installed.

PART 2 – EXECUTION

- 2.1 Grounding
 - 2.1.1 All panelboard cabinets, equipment, enclosures, and complete conduit system shall be grounded securely in accordance with pertinent sections of CEC Article 250. Conductors shall be copper. All electrically operated equipment shall be bonded to the grounded conduit system. All non-current carrying conductive surfaces that are likely to become energized and subject to personal contact shall be grounded by one or more of the methods detailed in CEC Article 250. All ground connections shall have clean contact surfaces. Install all grounding conductors in conduit and make connections readily accessible for inspection.
 - 2.1.2 Provide an insulated equipment grounding conductor in all branch circuit and feeder raceway systems, sized in accordance with CEC 250-1122.
 - 2.1.3 Provide an additional individual insulated grounding conductor for each circuit which contains an isolated ground receptacle or surge suppression receptacle.
 - 2.1.4 Grounding of metal raceways shall be assured by means of provisions of grounding bushings on feeder conduit terminations at the panelboard,



and by means of insulated continuous stranded copper grounding wire extended from the ground bus in the panelboard to the conduit grounding bushings.

- 2.1.5 Except for connections which access for periodic testing is required, make grounding connections which are buried or otherwise inaccessible by exothermite type process.
- 2.1.6 The following ohmic values shall be test certified for each item listed. A written report signed and witnessed by the project IOR shall be provided to the engineer. If the ohmic value listed cannot be obtained additional grounding shall be installed to reach the value listed.

 - 2.1.6.2 Step down transformers and non-current carrying metal parts 25 ohms.
 - 2.1.6.3 Manholes, handholes, etc.

END OF SECTION

SECTION 26 05 33

CONDUIT AND FITTINGS

PART 1 – GENERAL

- 1.1 Furnish and install conduit and fittings as shown on the drawings and as specified herein.
- 1.2 Submit Manufacturer's data on the following:
 - 1.2.1 Conduit.
 - 1.2.2 Fittings
 - 1.2.3 Fire stopping Material.
 - 1.2.4 Surface Raceways.
 - 1.2.5 Type MC or MC-PCS cable provide construction details and UL "E" number.

1.3 Common submittal mistakes which will result in the submittals being rejected:

- 1.3.1 Not including all items listed in the above itemized description.
- 1.3.2 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.
- 1.3.3 Not including actual manufacturer's catalog information of proposed products.
- 1.3.4 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements, or "to be determined later" statements. The products being submitted must be the products installed.

PART 2 – PRODUCTS

- 2.1 Rigid steel conduit, intermediate metal conduit (IMC), electrical metallic tubing (EMT) and flexible metallic conduit shall be steel, hot dipped galvanized after fabrication.
- 2.2 PVC conduit shall be Carlon or approved equal.
- 2.3 Liquid tight flexible metal conduit shall be Anaconda Sealtite type UA or approved equal. Fittings shall be Appleton, Crouse-Hinds, Steel City, T&B, or equivalent.

- 2.4 MC type armored cable, when utilized, shall be provided with the following:
 - 2.4.1 Comply with UL 1479 and CEC 330
 - 2.4.2 90°C, copper, THHN conductors.
 - 2.4.3 Minimum #12 insulated grounding conductor.
 - 2.4.4 Conductors sized No. 10 and smaller shall be solid, No. 8 and larger shall be stranded.
 - 2.4.5 Oversized (150%) neutrals or separate neutrals shall be provided.
 - 2.4.6 Increase phase conductors to No. 10 AWG for 120 volt circuits greater than 100 feet from panel to load and for 277 volt circuits greater than 200 feet from panel to load. Where required increase conductor sizes for entire length of circuit.
 - 2.4.7 Interlocked armored <u>aluminum</u> sheath.
 - 2.4.8 AC or BX type armored cable shall <u>not</u> be substituted in lieu of MC type cable.
 - 2.4.9 Color code cable according to cable type and configuration.
 - 2.4.10 Acceptable manufacturers are AFC and Alflex.
- 2.5 MC-PCS luminary armored cable when utilized, shall be provided with the following:
 - 2.5.1 Comply with UL 1479 and CEC 330
 - 2.5.2 90°C, copper, THHN conductors.
 - 2.5.3 Minimum #12 insulated grounding conductor.
 - 2.5.4 Lighting phase conductors sized No. 10 and smaller shall be solid, lighting control conductors shall be sized no. 16 solid.
 - 2.5.5 Interlocked armored <u>aluminum</u> sheath.
 - 2.5.6 AC or BX type armored cable shall <u>not</u> be substituted in lieu of MC type cable.
 - 2.5.7 Color code phase cable according to cable type and configuration. color code control conductors purple/gray.
 - 2.5.8 Acceptable manufacturers are AFC and Alflex.

- 2.6 Fire stopping material shall provide an effective seal against fire, heat, smoke and fire gases. Fire stopping material shall be tested to comply with ASTME 814 and UL 1479. The submittal for this product shall include the UL listed system number and installation requirements for each type of penetration seal required for this project.
- 2.7 Each length of conduit shall be stamped with the name or trademark of the manufacturer and shall bear the UL label.
- 2.8 All plastic conduit shall be rigid, schedule 40, heavy wall PVC. All PVC conduit shall be UL listed. Underground utility company conduits shall comply with local utility co. requirements.
- 2.9 Plastic conduit shall be stored on a flat surface, and protected from the direct rays of the sun.
- 2.10 Where branch circuit or communication raceways cannot be concealed in ceilings or walls and are required to be exposed in interior spaces, provide nonmetallic surface raceway system sized per the manufacturer capacity requirements. A full complement of nonmetallic fittings must be available and matching device boxes and cover plates must be provided. The color of the raceway system, components and boxes shall be (white). Where data networking cabling is to be installed, all raceway fittings shall meet Category 5 radius requirements. Where specific raceway types have been noted on the drawings they shall be as follows:

2.10.1	System 'SR'	Hubbell Wiremold Panduit Hellerman-Tyton	WALLTRAK 1 series ECLIPSE PN05series LD5 series TSR2 series
2.10.2	System 'SR2'	Hubbell Wiremold Panduit Hellerman-Tyton	WALTRAK 22 2300D Series D2P10 TSR3 series
2.10.3	System 'SR3'	Hubbell Wiremold Panduit Hellerman-Tyton Provide with offset bo	BASETRAK series 5400 - series 70 series MCR Infostream'' series wxes, inline boxes may only be used

where specifically shown on the drawings.

PART 3 – FITTINGS

- 3.1 All metallic fittings, including those for EMT, flexible conduit, or malleable iron. Die cast fittings of any other material are not permitted.
- 3.2 Locknuts shall be steel or malleable iron with sharp clean cut threads.

- 3.3 Entrance seals shall be 0.Z. type FSK or equivalent.
- 3.4 Bushings and locknuts: Where conduits enter boxes, panels, cabinets, etc., they shall be rigidly clamped to the box by locknuts on the outside, and a lock nut and plastic bushing on the inside of the box. All conduits shall enter the box squarely.
- 3.5 Furnish and install insulated bushings as per CEC article No. 300 4 (F) on all conduits. The use of insulated bushings does not exclude the use of double locknuts to fasten conduit to the box.
- 3.6 Transition from plastic to steel conduits shall be with PVC female threaded adaptors.
- 3.7 Couplings and connectors for rigid steel or IMC conduit must be threaded, or compression type (set screw fittings are not permitted).
- 3.8 Couplings and connectors for EMT shall be compression, watertight. Set screw connectors are not acceptable, except for systems below 120 volts.
- 3.9 MC or MC-PCS type armored cable shall be provided with listed clamp type die cast zinc set screw connectors. Anti-short bushings shall be provided at all cable ends.
- 3.10 Connectors for flexible metal conduit shall be steel or malleable iron with screw provided to clinch the conduit into the adapter body. For sizes up to ³/₄" a screw-in, "Jake type," fitting may be used.
- 3.11 Install approved expansion fittings, or liquid tight flex conduit with a minimum 6" slack for conduits passing through all expansion and seismic joints.

PART 4 - EXECUTION

- 4.1 All branch circuits shall be installed concealed in walls or above ceilings or in concrete floor slabs. PVC conduits installed in concrete floor slabs shall transition to PVC coated rigid steel where conduits penetrate above finished grade or finished floor.
- 4.2 Conduit sizes for various numbers and sizes of wire shall be as required by the CEC, but not smaller than ½" for power wiring and ¾" for communications and fire alarm systems unless otherwise noted. Conduit in slab or below grade shall be ¾" minimum trade size, unless otherwise identified.
- 4.3 Conduit size shall be such that the required number and sizes of wires can be easily pulled in and the Contractor shall be responsible for the selection of the conduit sizes to facilitate the ease of pulling. Conduit sizes shown on the drawings are minimum sizes in accordance with appropriate tables in the CEC. If because of bends or elbows a larger conduit size is required, the Contractor shall so furnish without further cost to the Owner.

- 4.4 The Contractor shall be entirely responsible for the proper protection of this work from the other trades on the job. When conduit becomes bent or holes are punched through same, or outlets moved after being roughed-in, the Contractor shall replace same, without additional cost to the Owner.
- 4.5 Rigid steel conduit or IMC shall be used as follows:
 - 4.5.1 Exposed exterior locations.
 - 4.5.2 Exposed interior locations below eight feet above floor, except in electrical rooms and closets.
 - 4.5.3 In hazardous or classified areas as required by CEC.
- 4.6 EMT conduit shall be used for areas as follows:
 - 4.6.1 All interior communications, signal, and data networking systems.
 - 4.6.2 All interior power wiring systems where not required to be in rigid steel, IMC or flexible conduit.
- 4.7 Flexible conduit shall be used for areas as follows:
 - 4.7.1 To connect motors, transformers, and other equipment subjected to vibration or where specifically detailed on the drawings.
 - 4.7.2 Flexible conduit shall not be used to replace EMT in other locations where the conduit will be exposed.
 - 4.7.3 Flexible metal conduit shall be ferrous. Installation shall be such that considerable slack is realized. The conduit shall contain separate code sized grounding conductor.
 - 4.7.4 Liquid tight flexible conduit shall be used in conformance with CEC in lengths not to exceed 4'. For equipment connections, route the conduit at 90 degrees to the adjacent path for point of connection. The conduit shall contain separate code sized grounding conductor. Use liquid tight flexible conduit for all equipment connections exposed in possible wet, corrosive or oil contaminated areas, e.g., shops and outside areas.
- 4.8 MC armored cable may be used as follows:
 - 4.8.1 All branch circuit wiring for lighting and power circuits where permitted and installed in compliance with UL 1569 and CEC 330.
- 4.9 MC-PCS luminary armored cable may be used as follows:
 - 4.9.1 All Lighting branch circuit wiring for lighting circuits where permitted and installed in compliance with UL 1569 and CEC 300-22(c), 330. This cable



permits conductors of control circuits to be placed in a cable with lighting power circuits or class 1 circuits.

- 4.9.2 It shall not be considered an acceptable option to install lighting control class 1 circuits as an open wire installation.
- 4.10 MC and MC-PCS armored cable shall <u>not</u> be used for the following areas:
 - 4.10.1 Any exterior, underground or buried in concrete circuits.
 - 4.10.2 Any circuits feeding HVAC equipment or pumps or any circuit with 30 AMPs or greater overcurrent protection.
 - 4.10.3 Any exposed interior locations except in electrical, communication or mechanical equipment rooms.
 - 4.10.4 Any exposed interior damp/wet locations, kitchens, science classrooms, shop areas, or concealed in science classroom casework, unless provided with approved PVC jacket.

4.10.5 Any hazardous rated area.

- 4.11 Plastic conduit shall be used for all exterior underground, in slab, and below slab on grade conduit installations. Install bell ends at all conduit terminations in manholes and pull boxes. Where plastic conduit transitions from below grade to above grade, <u>no plastic conduit shall extend above finished exterior grade, or</u> <u>above interior finished floor level</u>.
- 4.12 Plastic conduit joints shall be made up in accordance with the manufacturer's recommendations for the particular conduit and coupling selected. Conduit joint couplings shall be made watertight. Plastic conduit joints shall be made up by brushing a plastic solvent cement on the inside of a plastic fitting and on the outside of the conduit ends. The conduit and fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly.
- 4.13 All underground conduit depths shall be as detailed on the drawings or a minimum of 30" below finished grade (when not specifically detailed otherwise), for all exterior underground conduits. Where concrete slurry or concrete encasement is provided, include "Red" color dye in mixture.
- 4.14 All underground conduits for power systems (600v and higher), shall be concrete encased and a minimum of 48" below grade or as detailed on the drawings. Where concrete slurry or concrete encasement is provided, include "Red" color dye in mixture.
- 4.15 Conduit shall be continuous from outlet to outlet, cabinet or junction box, and shall be so arranged that wire may be pulled in with the minimum practical number of junction boxes.

- 4.16 All conduits shall be concealed wherever possible. All conduit runs may be exposed in mechanical equipment rooms, electrical equipment rooms, electrical closets, and in existing or unfinished spaces. No conduit shall be run exposed in finished areas without the specific approval of the Architect.
- 4.17 All raceways which are not buried or embedded in concrete shall be supported by straps, clamps, or hangers to provide a rigid installation. Exposed conduit shall be run in straight lines at right angles to or parallel with walls, beams, or columns. In no case shall conduit be supported or fastened to other pipes or installed to prevent the ready removal of other trades piping. Wire shall not be used to support conduit.
- 4.18 It shall be the responsibility of the Contractor to consult the other trades before installing conduit and boxes. Any conflict between the location of conduit and boxes, piping, duct work, or structural steel supports, shall be adjusted before installation. In general, large pipe mains, waste, drain, and steam lines shall be given priority.
- 4.19 Conduits above lay-in grid type ceilings shall be installed in such a manner that they do not interfere with the "lift-out" feature of the ceiling system. Conduit runs shall be installed to maintain the following minimum spacing wherever practical.
 - 4.19.1 Water and waste piping not less than 3".
 - 4.19.2 Steam and steam condensate lines not less than 12".
 - 4.19.3 Radiation and reheat lines not less than 6".
- 4.20 Provide all necessary sleeves and chases required where conduits pass through floors or walls as part of the work of this section. Core drilling will only be permitted where approved by the Architect.
- 4.21 All empty conduits and surface mounted raceways shall be provided with a ¼" polypropylene plastic pull cord and threaded plastic or metal plugs over the ends. Fasten plastic "Dymo" tape label to exposed spare conduit to identify "power" or "communication" system, and to where it goes.
- 4.22 The ends of all conduits shall be securely plugged, and all boxes temporarily covered to prevent foreign material from entering the conduits during construction. All conduit shall be thoroughly swabbed out with a dry swab to remove moisture and debris before conductors are drawn into place.
- 4.23 Bending: Changes in direction shall be made by bends in the conduit. These shall be made smooth and even without flattening the pipe or flaking the finish. Bends shall be of as long a radius as possible, and in no case smaller than CEC requirements.
 - 4.23.1 For power conduits for conductors (600v and below), provide minimum 36" radius (vertical) and 72" radius (horizontal) bends.

- 4.23.2 For power conduits for conductors (greater than 600v), provide minimum 72" radius (vertical) and 72" radius (horizontal) bends.
- 4.24 Supports: Conduit shall be supported at intervals as required by the California Electrical Code. Where conduits are run individually, they shall be supported by approved conduit straps or beam clamps. Straps shall be secured by means of toggle bolts on hollow masonry, machine screws or bolts on metal surfaces, and wood screws on wood construction. [No perforated straps or wire hangers of any kind will be permitted. Where individual conduits are routed, or above ceilings, they shall be supported by hanger rods and hangers.] Conduits installed exposed in damp locations shall be provided with clamp backs under each conduit clamp, to prevent accumulation of moisture around the conduits.
- 4.25 Where a number of conduits are to be run exposed and parallel, one with another, they shall be grouped and supported by trapeze hangers. Hanger rods shall be fastened to structural steel members with suitable beam clamps or to concrete inserts set flush with surface. A reinforced rod shall be installed through the opening provided in the concrete inserts. Beam clamps shall be suitable for structural members and conditions. Rods shall be galvanized steel 3/8" diameter minimum. Each conduit shall be clamped to the trapeze hanger with conduit clamps.
- 4.26 All concrete inserts and pipe clamps shall be galvanized. All steel bolts, nuts, washers, and screws shall be galvanized or cadmium plated. Individual hangers, trapeze hangers and rods shall be prime-coated.
- 4.27 Openings through fire rated floors/walls and/or smoke walls through which conduits pass shall be sealed by Fire stopping material to comply with Division 1 to seal off flame, heat, smoke and fire gases. Sleeves shall be provided for power or communication system cables which are not installed in conduits, and shall be sealed inside and out to comply with manufacturers UL system design details. Where multiple conduits and/or cable tray systems pass thru fire-rated walls at one location, the Contractor shall submit copies of the manufacturers UL system design details proposed for use on this project. All Fire stopping material shall have an hourly fire-rating equal to or higher than the fire rating of the floor or wall through which the conduit, cables, or cable trays pass.
- 4.28 Provide cap or other sealing type fitting on all spare conduits. Conduits stubbed into buildings from underground where cable only extends to equipment, the conduit/cable end shall be sealed to prevent moisture from entering the room or space.
- 4.29 All conduits which are part of a paralleled feeder or branch circuit shall be installed underground.
- 4.30 All conduits which are required as a part of systems specified in Divisions 27 or 28, or any other low voltage communication systems, shall be furnished and installed by the Division 26 Contractor.

- 4.30.1 The Contractor shall coordinate all conduit requirements with each system supplier prior to bid to determine special conduit system requirements.
- 4.30.2 The Contractor shall provide a pull rope in all conduits for these systems.
- 4.30.3 The Contractor shall provide conduit sleeves for all open cable installations thru rated walls or block walls. Provide conduit from each building main termination cabinet or backboard to the nearest accessible ceiling for access into all electrical or communications rooms.
- 4.31 In addition to the above requirements, the following requirements shall apply to all data networking conduits:
 - 4.31.1 Flexible metal conduit may only be used where required at building seismic and/or expansion joints.
 - 4.31.2 All underground conduits shall be provided with minimum 24" radius elbows (vertical) and 60" (horizontal).
 - 4.31.3 No length of conduit above grade shall be installed to exceed 150 feet between pull boxes, or points of connection, unless where specifically detailed on the drawings.
 - 4.31.4 No length of conduit shall be installed to exceed two 90 degree bends between pull boxes, or points of connection, unless where specifically detailed on the drawings.
- 4.32 Where surface raceways are installed in interior spaces, the Contractor shall take care to route in straight lines at right angles to or parallel with walls, beams, or columns. All raceways and device boxes shall be securely screwed to the finish surface with zinc screw "Auger" anchors Stk #ZSA1K by Gray Bar Electric or equal. Tape adhesive application will not be permitted.
- 4.33 The Contractor who installs surface raceway systems shall provide and install complete with wire retention clips, one for every (8) vertical feet or (5) horizontal feet or portion thereof. This Contractor shall also provide <u>each</u> raceway channel with pull strings.
- 4.34 It shall be the responsibility of the Contractor installing the raceway to coordinate the installation of raceway device plates and inserts with the communications or data contractors.
- 4.35 MC or MC-PCS cable shall be cut using a specific metallic sheath armor stripping tool. The use of hacksaws, dikes or any other tools not specifically designed to remove the armor sheath will not be permitted.
- 4.36 MC or MC-PCS cables installed in attic spaces or above lay-in ceilings shall be installed to be protected from physical damage. The cable shall be mounted along the sides or bottom of joists, rafters or studs.

- 4.37 Support wires used for supporting ceilings, lighting fixtures or other equipment items shall <u>not</u> be used to support MC or MC-PCS cables. Conduits, duct work, piping or any other equipment shall not be used to support or mount MC cables.
- 4.38 MC or MC-PCS cable supports, fasteners and clips shall be designed specifically for use with MC cables. Standard conduit supports, fasteners and clips, nails or other items are not permitted for installing MC cables.

END OF SECTION

SECTION 26 05 34

OUTLET AND JUNCTION BOXES

PART 1 – GENERAL

- 1.1 Furnish and install electrical wiring boxes as specified and as shown on the electrical drawings.
- 1.2 Submit manufacturer's data for all items.

1.3 <u>Common submittal mistakes which will result in the submittals being</u> rejected:

- 1.3.1 Not including all items listed in the above itemized description.
- 1.3.2 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.
- 1.3.3 Not including actual manufacturer's catalog information of proposed products.
- 1.3.4 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements, or "to be determined later" statements. The products being submitted must be the products installed.

PART 2 – PRODUCTS

- 2.1 Boxes shall be as manufactured by Steel City, Appleton, Raco, or approved equal.
- 2.2 All boxes must conform to the provisions of Article 370 of the CEC. All boxes shall be of the proper size to accommodate the quantity of conductors enclosed in the box. Minimum box size shall be 4" square x $1-\frac{1}{2}$ " deep.
- 2.3 Boxes generally shall be hot dipped galvanized steel with knockouts. Boxes on exterior surfaces or in damp locations shall be corrosion resistant, cast feraloy and shall have threaded hubs for rigid conduit and neoprene gaskets for their covers. Boxes shall be Appleton Type FS, Crouse-Hinds, or the approved equal. Conduit bodies shall be corrosion resistant, cast malleable iron. Conduit bodies shall have threaded hubs for rigid conduit and neoprene gaskets for their covers. Conduit bodies shall be Appleton Unilets, Crouse-Hinds, or the approved equal. Where recessed, boxes shall have square cut corners.
- 2.4 Deep boxes shall be used in wall covered by wainscot or paneling and in walls or glazed tile, brick, or other masonry which will not be covered with plaster. Through the wall type boxes shall not be used unless specifically called for. All

boxes shall be nongangable. Boxes in concrete shall be of a type to allow the placing of conduit without displacing the reinforcing bars. All lighting fixture outlet boxes shall be equipped with the proper fittings to support and attach a light fixture.

- 2.5 All light, switch, receptacle, fire alarm devices and similar outlets shall be provided with approved boxes, suitable for their function. Back boxes shall be furnished and installed as required for the equipment and/or systems under this contract.
- 2.6 Pull and junction boxes shall be code gauge boxes with screw covers. Boxes shall be rigid under torsional and deflecting forces and shall be provided with angle from framing where required. Boxes shall be 4" square with a blank cover in unfinished areas and with a plaster ring and blank cover in finished areas. Covers for flush mounted oversize boxes shall extend ³/₄" past boxes all around. Covers for 4" square boxes shall extend ¹/₄" past box all around.
- 2.7 All terminal cabinets and junction boxes or equipment back boxes which are required as a part of systems specified in Divisions 27 or 28, or any other low voltage communication systems, shall be furnished and installed by the Division 26 Contractor.
 - 2.7.1 The Division 26 Contractor shall coordinate all box requirements with each system supplier prior to bid to determine special cabinet or back box requirements. The Contractor shall also provide stainless steel blank cover plates for all low voltage systems installed for future equipment.
 - 2.7.2 The Contractor shall provide all plywood backboards indicated on walls or inside equipment enclosures. All backboards shall be a minimum of ³/₄" thick fire rated type plywood.
 - 2.7.3 The Contractor shall coordinate exact rough in locations and requirements with each system supplier.
- 2.8 In addition to the above requirements, boxes for data networking wiring and equipment shall comply with the following:
 - 2.8.1 All boxes shall be a minimum of 4-11/16" square x 2-1/8" deep.
 - 2.8.2 Where pull boxes are required on individual conduits $1-\frac{1}{4}$ " or smaller, provide $4-\frac{11}{16}$ " square x $2-\frac{1}{8}$ " deep boxes. Where pull boxes are required on conduits larger than $1-\frac{1}{4}$ " for straight pull through, provide eight times the conduit trade size for box length. Where pull boxes are required on conduits larger than $1-\frac{1}{4}$ " for an angle or a U-pull through installation, provide a minimum distance of six times the conduit trade size between the entering and exiting conduit run for each cable.
- 2.9 Recessed boxes installed in fire rated floors/walls and /or smoke walls shall be sealed by Fire stopping material to comply with Division 1 to seal off flame, heat,



smoke and fire gases. The Contractor shall submit copies of the manufacturers UL system design details proposed for use on this project. All Fire stopping material shall have an hourly fire-rating equal to or higher than the fire rating of the floor or wall through which the conduit, cables, or cable trays pass.

PART 3 – EXECUTION

- 3.1 Boxes shall be installed where required to pull cable or wire, but in finished areas only by approval of the Architect. Boxes shall be rigidly attached to the structure, independent of any conduit support. Boxes shall have their covers accessible. Covers shall be fastened to boxes with machine screws to ensure continuous contact all around. Covers for surface mounted boxes shall line up evenly with the edges of the boxes.
- 3.2 Outlets are only approximately located on the plans and great care must be used in the actual location of the outlets by consulting the various detailed drawings and specifications. Outlets shall be flush with finished wall or ceiling, boxes installed symmetrically on such trim or fixture. Refer to drawings for location and orientation of all outlet boxes.
- 3.3 Furnish and install all plaster rings as may be required. Plaster rings shall be installed on all boxes where the boxes are recessed. Plaster rings shall be of a depth to reach the finished surface. Where required, extension rings shall be installed so that the plaster ring is flush with the finished surface.
- 3.4 All cabinets and boxes shall be secured by means of toggle bolts on hollow masonry; expansion shields and machine screws or standard precast inserts on concrete or solid masonry; machine screws or bolts on metal surfaces and wood screws on wood construction. All wall and ceiling mounted outlet boxes shall be supported by bar supports extending from the studs or channels on either side of the box. Boxes mounted on drywall or plaster shall be secured to wall studs or adequate internal structure.
- 3.5 Boxes with unused punched-out openings shall have the openings filled with factory-made knockout seals.
- 3.6 Where standby power and normal power are to be located in the same outlet box or 480V in a switch box, install partition barriers to separate the various systems.
- 3.7 All device boxes and junction boxes for fire alarm system shall be painted red and shall be 4-11/16" square by 2-1/8" deep. No exceptions.

END OF SECTION

SECTION 26 05 43

UNDERGROUND PULL BOXES AND MANHOLES

PART 1 – GENERAL

- 1.1 Furnish and install electrical underground pullboxes and manholes as specified and as shown on the electrical drawings.
- 1.2 Submit manufacturer's data for all items.

1.3 Common submittal mistakes which will result in the submittals being rejected:

- 1.3.1 Not including all items listed in the above itemized description.
- 1.3.2 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.
- 1.3.3 Not including actual manufacturer's catalog information of proposed products.
- 1.3.4 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements or "to be determined later" statements. The products being submitted must be the products installed.

PART 2 – PRODUCTS

- 2.1 The concrete for pull boxes and manholes shall be class 5500 psi or as noted on the drawings. All pullboxes and manholes and covers located in parking lots, driveways, roads, or any other driveable areas shall be traffic rated.
- 2.2 Each manhole shall be provided with a fiberglass ladder and ground rod. Ground rods shall be copper or a copper-clad steel 3/4" diameter by 10-feet long. All non-current carrying metallic components shall be grounded to the ground rods with minimum #6 copper wire.
- 2.3 All underground pullboxes shall be provided with steel bolt down type covers. Bolts shall be bronze or brass. All communication or signal system pullboxes shall be sized to comply with CEC Article 370 unless where other sizes are specifically noted on the drawings.
- 2.4 All underground pullbox and manhole covers shall be provided with either "electrical" or "telephone" or "fire alarm" markings. The telephone marking shall be used to identify telephone, T.V., clock or any other types of communication systems.

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2.5 All power and communication systems shall be provided with separate pullboxes or manholes. Fire alarm circuits shall also be provided with separate pullboxes from any other type of communication systems.

PART 3 – INSTALLATION

- 3.1 Shoring of the excavation shall be in accordance with all federal, state and local regulations.
- 3.2 Provide sealing material for the joints between sections per manufacturer's instructions.
- 3.3 The contractor shall make the top and access assembly or lid flush with surrounding areas where installed in driveable or normal walking areas.

END OF SECTION

SECTION 26 09 23

DIGITAL LIGHTING CONTROL SYSTEM

PART 1 – GENERAL

- 1.1 Furnish and install automatic lighting controls as shown on the drawings and as specified herein Submit manufacturers' data on all items.
- 1.2 Equipment shall be UL listed, comply with those portions of CEC as applicable to electrical wiring work and comply with those portions of NEMA or UL pertaining to types of electrical equipment and enclosures. The equipment shall also be certified by the California Energy Commission.
- 1.3 The manufacturer of the lighting control equipment shall have been actively engaged in the manufacture of the types and capacities required for the application for at least three years. It is the sole responsibility of the Division 26 contractor to ensure that submittals of material meets the performance specifications contained herein.
- 1.4 All components and assemblies shall be factory pre-tested and burned-in as a system for 48 hours prior to shipping.
- 1.5 Control Intent Control Intent includes, but is not limited to:
 - 1.5.1 Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
 - 1.5.2 Initial sensor and switching zones
 - 1.5.3 Initial time switch settings
 - 1.5.4 Task lighting and receptacle controls
 - 1.5.5 Emergency Lighting control (if applicable)
 - 1.5.6 Manufacturer shall submit a point-to-point line diagram of the system configuration including all devices and accessories required to complete the system.
 - 1.5.7 Manufacturer shall submit data sheets on the components and system submitted, with descriptions of hardware and software components.

SYSTEM DESCRIPTION & OPERATION

- 1.6 The Lighting Control and Automation system as defined under this section covers the following equipment:
 - 1.6.1 Digital Occupancy Sensors Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications

- 1.6.2 Digital Switches Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications
- 1.6.3 Handheld remotes for personal control One-button dimming, two-button on/off, or five-button scene remotes provide control using infrared communications. Remote may be configured in the field to control selected loads or scenes without special tools
- 1.6.4 Digital Daylighting Sensors Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications can provide switching, bi-level, tri-level or dimming control for daylight harvesting
- 1.6.5 Digital Room Controllers Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities
- 1.6.6 Digital Plug-Load Controllers Self-configuring, digitally addressable, single relay, plenum-rated application-specific controllers. Selected models include integral current monitoring capabilities
- 1.6.7 Configuration Tools Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow bi-directional communication of room variables and occupancy sensor settings. Computer software also customizes room settings
- 1.6.8 Digital Lighting Management (DLM) local network Free topology, plug-in wiring system (Cat 5e) for power and data to room devices
- 1.6.9 Digital Lighting Management (DLM) segment network Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded,) to connect multiple DLM local networks for centralized control
- 1.6.10 Network Bridge provides BACnet MSTP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
- 1.6.11 Segment Manager provides web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting
- 1.6.12 Programming and Configuration software Optional PC-native application capable of accessing DLM control parameters within a room,



for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication

- 1.6.13 LMCP Digital Lighting Management Relay Panel provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS)
- 1.6.14 Emergency Lighting Control Unit (ELCU) allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

LIGHTING CONTROL APPLICATIONS

- 1.7 Unless relevant provisions of the applicable local Energy Codes are more stringent, provide a minimum application of lighting controls as follows:
 - 1.7.1 Space Control Requirements Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-ON switches.
 - 1.7.2 Bi-Level Lighting Provide multi-level controls in all spaces except toilet rooms, storerooms, library stacks, or applications where variable dimming is used
 - 1.7.3 Task Lighting / Plug Loads Provide automatic shut off of non-essential plug loads and task lighting in all spaces except toilet rooms and storerooms. Provide Automatic-ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area
 - 1.7.4 Daylit Areas Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:
 - 1.7.4.1 All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones

- 1.7.4.2 Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes
- 1.7.4.3 Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on drawings
- 1.7.4.4 Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
- 1.7.5 Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four (4) pre-set lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to extinguish all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.
- 1.8 Submit shop drawings and manufacturers' data for all components including:
 - 1.8.1 Manufacturer shall submit in bill-of-material form an itemized list of all materials supplied to meet the specification.
 - 1.8.2 Manufacturer shall submit dimensional drawings of lighting control panel(s).
 - 1.8.3 Manufacturer shall submit a point-to-point line diagram of the system configuration including all devices and accessories required to complete the system.
 - 1.8.4 Manufacturer shall submit data sheets on the components and system submitted, with descriptions of hardware and software components
 - 1.8.5 Composite wiring and/or schematic diagram of each control circuit as proposed to be installed
 - 1.8.6 Show exact location of all digital devices, including at minimum sensors, room controllers, and switches for each area on reflected ceiling plans. (Contractor must provide AutoCAD format reflected ceiling plans)
 - 1.8.7 Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies
 - 1.8.8 Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required.

Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades

QUALITY ASSURANCE

1.9 Manufacturer: Minimum 10 years' experience in manufacture of lighting controls

PROJECT CONDITIONS

- 1.10 Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1.10.1 Ambient temperature: 0° to 40° C (32° to 104° F)
 - 1.10.2 Relative humidity: Maximum 90 percent, non-condensing.

WARRANTY

1.11 Provide a five year limited manufacturer's warranty on all room control devices and panels

MAINTENANCE

- 1.12 Spare Parts:
 - 1.12.1 Provide 5% spares of each product to be used for this project. All unused items shall be boxed and delivered to the owner at the completion of the project.

PART 2 – PRODUCTS

2.1 Acceptable Manufacturers: WattStopper, Digital Lighting Management (DLM)

Substitutions:

- 2.2 Bidder's wishing to obtain approval on manufacturers other than those specified in these specifications or on the drawings shall comply with the following procedures:
 - 2.2.1 All substitution requests shall be submitted to the Architect / Engineer no less than 10 business days prior to the project bid opening date. Approvals when accepted will be issued in the form of an addendum to the contract. No consideration for substitutions will be provided after the award of the contract.
 - 2.2.2 The substitution request must include a statement indicating how the substituted product may impact the completion of the project.

- 2.2.3 The substitution request must include a statement indicating the difference in price (both list price and Contractor price) between the specified product and the substitution.
- 2.2.4 The substitution request must include a detailed analysis indicating <u>any</u> differences between the specified product and the substitution.
- 2.2.5 Catalog literature for both the specified and the substitution shall be provided along with contact information of the manufacturer for the substituted product.
- 2.3 The contractor shall pay the Engineer (at their current standard hourly rates) for the time spent reviewing substitutions. These costs will be included as an addendum to be issued to all bidders to include in their proposals, and must be paid to the Engineer within 60 days of award of the project.

DIGITAL LIGHTING CONTROLS

2.4 Furnish the Company's system which accommodates the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories which suit the lighting and electrical system parameters.

DIGITAL WALL SWITCH OCCUPANCY SENSORS

- 2.5 Wallbox mounted passive infrared PIR or dual technology (passive infrared and ultrasonic) digital occupancy sensor with 1 or 2 switch buttons
- 2.6 Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
 - 2.6.1 Digital calibration and pushbutton configuration for the following variables:
 - 2.6.1.1 Sensitivity 0-100% in 10% increments
 - 2.6.1.2 Time delay 1-30 minutes in 1 minute increments xx
 - 2.6.1.3 Test mode Five second time delay
 - 2.6.1.4 Detection technology PIR, Dual Technology activation and/or reactivation.
 - 2.6.1.5 Walk-through mode
 - 2.6.1.6 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network
 - 2.6.2 Programmable control functionality including:
- 2.6.2.1 Each sensor may be programmed to control specific loads within a local network
- 2.6.2.2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.
- 2.6.2.3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
- 2.6.2.4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:

2.6.2.4.1 Ultrasonic and Passive Infrared

- 2.6.2.4.2 Ultrasonic only
- 2.6.2.4.3 Passive Infrared only
- 2.6.3 Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods
- 2.6.4 Two RJ-45 ports for connection to DLM local network
- 2.6.5 Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote person controls.
- 2.6.6 Device Status LEDs including:
 - 2.6.6.1 PIR detection
 - 2.6.6.2 Ultrasonic detection
 - 2.6.6.3 Configuration mode
 - 2.6.6.4 Load binding
- 2.6.7 Assignment of occupancy sensor to a specific load within the room without wiring or special tools
- 2.6.8 Assignment of local buttons to specific loads within the room without wiring or special tools
- 2.6.9 Manual override of controlled loads
- 2.6.10 All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall

switch sensor itself. Memory shall have an expected life of no less than 10 years.

- 2.7 BACnet object information shall be available for the following objects:
 - 2.7.1 Detection state
 - 2.7.2 Occupancy sensor time delay
 - 2.7.3 Occupancy sensor sensitivity, PIR and Ultrasonic
 - 2.7.4 Button state
 - 2.7.5 Switch lock control
 - 2.7.6 Switch lock status
- 2.8 Units shall not have any dip switches or potentiometers for field settings
- 2.9 Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required
- 2.10 Two-button wall switch occupancy sensors, when connected to a single relay dimming room controller, shall operate in the following sequence as a factory default:
 - 2.10.1 Left button
 - 2.10.1.1 Press and release Turn load on
 - 2.10.1.2 Press and hold Raise dimming load
 - 2.10.2 Right button
 - 2.10.2.1 Press and release Turn off
 - 2.10.2.2 Press and hold Lower diming load
- 2.11 Low voltage momentary pushbuttons shall include the following features:
 - 2.11.1 Load/Scene Status LED on each switch button with the following characteristics:
 - 2.11.1.1 Bi-level LED
 - 2.11.1.2 Dim locator level indicates power to switch
 - 2.11.1.3 Bright status level indicates that load or scene is active

- 2.11.2 The following button attributes may be changed or selected using a wireless configuration tool:
 - 2.11.2.1 Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 - 2.11.2.2 Individual button function may be configured to Toggle, On only or Off only.
 - 2.11.2.3 Individual scenes may be locked to prevent unauthorized change.
 - 2.11.2.4 Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - 2.11.2.5 Ramp rate may be adjusted for each dimmer switch.
 - 2.11.2.6 Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple load
- 2.12 WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening

DIGITAL WALL OR CELING MOUNTED OCCUPANCY SENSOR

- 2.13 Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor
- 2.14 Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 - 2.14.1 Digital calibration and pushbutton configuration for the following variables:
 - 2.14.1.1 Sensitivity 0-100% in 10% increments
 - 2.14.1.2 Time delay 1-30 minutes in 1 minute increments
 - 2.14.1.3 Test mode Five second time delay
 - 2.14.1.4 Detection technology PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - 2.14.1.5 Walk-through mode
 - 2.14.1.6 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.

2.14.2 Programmable control functionality including:

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- 2.14.2.1 Each sensor may be programmed to control specific loads within a local network.
- 2.14.2.2 Sensor shall be capable of activating one of 16 userdefinable lighting scenes.
- 2.14.2.3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off
- 2.14.2.4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - 2.14.2.4.1 Ultrasonic and Passive Infrared
 - 2.14.2.4.2 Ultrasonic or Passive Infrared
 - 2.14.2.4.3 Ultrasonic only
 - 2.14.2.4.4 Passive Infrared only
- 2.14.3 Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
- 2.14.4 One or two RJ-45 port(s) for connection to DLM local network
- 2.14.5 Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls
- 2.14.6 Device Status LEDs, which may be disabled for selected applications, including:
 - 2.14.6.1 PIR detection
 - 2.14.6.2 Ultrasonic detection
 - 2.14.6.3 Configuration mode
 - 2.14.6.4 Load binding
- 2.14.7 Assignment of occupancy sensor to a specific load within the room without wiring or special tools
- 2.14.8 Manual override of controlled loads
- 2.14.9 All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years

- 2.15 BACnet object information shall be available for the following objects:
 - 2.15.1 Detection state
 - 2.15.2 Occupancy sensor time delay
 - 2.15.3 Occupancy sensor sensitivity, PIR and Ultrasonic
- 2.16 Units shall not have any dip switches or potentiometers for field settings
- 2.17 Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
- 2.18 WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

DIGITAL WALL SWITCHES

- 2.19 Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
 - 2.19.1 Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 2.19.2 Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - 2.19.3 Configuration LED on each switch that blinks to indicate data transmission.
 - 2.19.4 Load/Scene Status LED on each switch button with the following characteristics:
 - 2.19.4.1 Bi-level LED
 - 2.19.4.2 Dim locator level indicates power to switch
 - 2.19.4.3 Bright status level indicates that load or scene is active
 - 2.19.5 Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps
 - 2.19.6 Programmable control functionality including

- 2.19.6.1 Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority.
- 2.19.6.2 Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels
- 2.19.7 All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years
- 2.20 BACnet object information shall be available for the following objects:
 - 2.20.1 Button state
 - 2.20.2 Switch lock control
 - 2.20.3 Switch lock status
- 2.21 Two RJ-45 ports for connection to DLM local network
- 2.22 Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching
- 2.23 The following switch attributes may be changed or selected using a wireless configuration tool:
 - 2.23.1 Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa)
 - 2.23.2 Individual button function may be configured to Toggle, On only or Off only.
 - 2.23.3 Individual scenes may be locked to prevent unauthorized change.
 - 2.23.4 Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours
 - 2.23.5 Ramp rate may be adjusted for each dimmer switch.
 - 2.23.6 Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads
- 2.24 WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening

HANDHELD REMOTE CONTROLS

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- 2.25 Battery-operated handheld devices in 1, 2 and 5 button configurations for remote switching or dimming control. Remote controls shall include the following features:
 - 2.25.1 Two-way infrared (IR) transceiver for line of sight communication with DLM local network within up to 30 feet
 - 2.25.2 LED on each button confirms button press
 - 2.25.3 Load buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads
 - 2.25.4 Inactivity timeout to save battery life
- 2.26 A wall mount holster and mounting hardware shall be included with each remote control
- 2.27 WattStopper part numbers: LMRH-101, LMRH-102, LMRH-105

DIGITAL PARTITION CONTROLS

- 2.28 Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors
- 2.29 Four-button low voltage pushbutton switch for manual control.
 - 2.29.1 Two-way infrared (IR) transceiver for use with configuration remote control.
 - 2.29.2 Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall
 - 2.29.3 Configuration LED on each switch that blinks to indicate data transmission.
 - 2.29.4 Each button represents one wall; Green button LED indicates status.
 - 2.29.5 Two RJ-45 ports for connection to DLM local network.
- 2.30 WattStopper part number: LMPS-104. Available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening
- 2.31 Contact closure interface for automatic control via input from limit switches on movable walls (by others).

- 2.31.1 Operates on Class 2 power supplied by DLM local network.
- 2.31.2 Includes 24VDC output and four input terminals for maintained third party contract closure inputs.
 - 2.31.2.1 Input max. sink/source current: 1-5Ma
 - 2.31.2.2 Logic input signal voltage High: >18VDC
 - 2.31.2.3 Logic input signal voltage Low: <2VDC
- 2.31.3 Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.
- 2.31.4 Two RJ-45 ports for connection to DLM local network.
- 2.32 WattStopper part number: LMIO-102

DIGITAL DAYLIGHTING SENSORS

- 2.33 Digital daylighting sensors shall work with room controllers to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to a room controller. Daylighting sensors shall be interchangeable without the need for rewiring
 - 2.33.1 Closed loop sensors measure the ambient light in the space and control a single lighting zone
 - 2.33.2 Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones
 - 2.33.3 Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone
- 2.34 Digital daylighting sensors shall include the following features:
 - 2.34.1 The sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers
 - 2.34.2 Sensor light level range shall be from 1-6,553 footcandles (fc).
 - 2.34.3 The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).

- 2.34.4 For switching daylight harvesting, the photosensor shall provide a fieldselectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
- 2.34.5 For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level
- 2.34.6 Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
- 2.34.7 Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off
- 2.34.8 Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy
- 2.34.9 Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls
- 2.34.10 Configuration LED status light on device that blinks to indicate data transmission
- 2.34.11 Status LED indicates test mode, override mode and load binding.
- 2.34.12 Recessed switch on device to turn controlled load(s) ON and OFF.
- 2.34.13 BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
 - 2.34.13.1 Day and night setpoints
 - 2.34.13.2 Off time delay
 - 2.34.13.3 On and off setpoints
 - 2.34.13.4 Up top three setpoints
 - 2.34.13.5 Operating mode on/off, bi-level, tri-level or dimming
- 2.34.14 One RJ-45 port for connection to DLM local network

- 2.35 A choice of accessories to accommodate multiple mounting methods and building materials. The photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62" thickness (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62"-1.25" thickness (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well
- 2.36 Any load or group of load in the room can be assigned to a daylighting zone
- 2.37 Each load within a daylighting zone can be individually enabled or disabled for discrete control) load independence)
- 2.38 All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years

Closed loop digital photosensors shall include the following additional features:

- 2.39 An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
- 2.40 Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software
- 2.41 Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads
- 2.42 WattStopper Product Number: LMLS-400, LMLS-400-L

Open loop digital photosensors shall include the following additional features:

- 2.43 An internal photodiode that measures light in a 60-degree angle cutting off the unwanted light from the interior of the room
- 2.44 Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone
- 2.45 Each of the three discrete daylight zones can include any non-overlapping group of loads in the room
- 2.46 WattStopper Product Number: LMLS-500, LMLS-500-L

Dual loop photosensors shall include the following additional features:

- 2.47 Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside.
- 2.48 Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room
- 2.49 Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load
- 2.50 Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is require
- 2.51 Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes
- 2.52 Device must include extendable mounting arm to properly position sensor within a skylight well
- 2.53 WattStopper product number LMLS-600

DIGITAL ROOM CONTROLLERS AND PLUG – LOAD CONTROLLERS

- 2.54 Digital controllers for lighting and plug loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room and plug load controllers shall be provided to match the room lighting and plug load control requirements. The controllers will be simple to install, and will not have dip switches or potentiometers, or require special configuration for standard Plug n' Go applications. The control units will include the following features:
 - 2.54.1 Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room
 - 2.54.2 Simple replacement Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf
 - 2.54.3 Multiple room controllers connected together in a local network must automatically prioritize each room controller, without requiring any configuration or setup, so that loads are sequentially assigned using room controller device ID's from highest to lowest

2.54.4 Device Status LEDs to indicate:

2.54.4.1	Data transmission
2.04.4.1	Data transmission

- 2.54.4.2 Device has power
- 2.54.4.3 Status for each load
- 2.54.4.4 Configuration status
- 2.54.5 Quick installation features including:
 - 2.54.5.1 Standard junction box mounting
 - 2.54.5.2 Quick low voltage connections using standard RJ-45 patch cable
- 2.54.6 Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power
 - 2.54.6.1 Turn on to 100%
 - 2.54.6.2 Remain off
 - 2.54.6.3 Turn on to last level
- 2.54.7 Each load shall be configurable to operate in the following sequences based on occupancy:
 - 2.54.7.1 Auto-on/Auto-off (Follow on and off)
 - 2.54.7.2 Manual-on/Auto-off (Follow off only)
- 2.54.8 The priority of each load output shall be reversible, via digital configuration, so that on is off and off is on
- 2.54.9 BACnet object information shall be available for the following objects:

2.54.9.1	Load status
2.54.9.2	Electrical current
2.54.9.3	Total watts per controller
2.54.9.4	Schedule state – normal or after-hours
2.54.9.5	Demand response control and cap level
2.54.9.6	Room occupancy status
2.54.9.7	Total room lighting and plug loads watts
	DIGITAL LIGHTING CONTROL SYSTEM

- 2.54.9.8 Total room watts/sq ft
- 2.54.9.9 Force on/off all loads
- 2.54.10 UL 2043 plenum rated
- 2.54.11 Manual override and LED indication for each load
- 2.54.12 Dual voltage (120/277 VAC, 60 Hz), or 347 VAC, 60 Hz (selected models only). 120/277 volt models rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming); 347 volt models rated for 15A total load; plug load controllers carry application-specific UL 20 rating for receptacle control.
- 2.54.13 Zero cross circuitry each load
- 2.54.14 All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- 2.55 On/Off Controllers shall include:
 - 2.55.1 One or two relay configuration
 - 2.55.2 Efficient 150 mA switching power supply
 - 2.55.3 Three RJ-45 DLM local network ports with integral strain relief and dust cover
 - 2.55.4 WattStopper product numbers: LMRC-101, LMRC-102
- 2.56 On/Off/Dimming enhanced Room Controllers shall include:
 - 2.56.1 Real time current monitoring
 - 2.56.2 Multiple relay configurations
 - 2.56.2.1 One, two or three relays (LMRC-21 x series)
 - 2.56.2.2 One or two relays (LMRC-22x series)
 - 2.56.3 Efficient 250 mA switching power supply
 - 2.56.4 Four RJ-45 DLM local network ports with integral strain relief and dust cover
 - 2.56.5 Once dimming output per relay

2.56.5.1 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED

drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting. (LMRC-21x series)

- 2.56.5.2 Line Voltage, Forward Phase Dimming Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. (LMRC-22x series)
- 2.56.5.3 Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver
- 2.56.5.4 The LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim
- 2.56.5.5 Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100% dimming range defined by the minimum and maximum calibration trim
- 2.56.5.6 Calibration and trim levels must be set per output channel
- 2.56.5.7 Devices that set calibration or trim levels per controller are not acceptable
- 2.56.5.8 All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable
- 2.56.6 Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events
- 2.56.7 Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value
- 2.56.8 The following dimming attributes may be changed or selected using a wireless configuration tool:
 - 2.56.8.1 Establish preset level for each load from 0-100%
 - 2.56.8.2 Set high and low trim for each load
 - 2.56.8.3 Set lamp burn in time for each load up to 100 hours

- 2.56.9 Override button for each load provides the following functions:
 - 2.56.9.1 Press and release for on/off control
 - 2.56.9.2 Press and hold for dimming control
- 2.57 WattStopper product numbers: LMRC-211, LRMC-212, LMRC-221, LMRC-222
- 2.58 Plug Load Room Controllers shall include the following:
 - 2.58.1 One relay configuration with additional connection for unswitched load
 - 2.58.2 Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated)
 - 2.58.3 Factory default operation is Auto-on/Auto-off, based on occupancy
 - 2.58.4 Real time current monitoring of both switched and un-switched load (LMPL-201 only)
 - 2.58.5 Efficient switching power supply
 - 2.58.5.1 150mA (LMPL-101)
 - 2.58.5.2 250mA (LMPL-201)
 - 2.58.6 RJ-45 DLM local network ports
 - 2.58.6.1 Three RJ-45 ports (LMPL-101)
 - 2.58.6.2 Four RJ-45 ports (LMPL-201)
- 2.59 Wattstopper product numbers: LMPL-101, LMPL-201
- DLM LOCAL NETWORK (Room Network)
- 2.60 The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building
- 2.61 Features of the DLM local network include:
 - 2.61.1 Plug n' Go® automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached
 - 2.61.2 Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup

- 2.61.3 Push n' Learn® configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network
- 2.61.4 Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver
- 2.62 Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable
- 2.63 If manufacturer's pre-terminated Cat 5e cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results
- 2.64 WattStopper Product Number: LMRJ-Series
- DLM SEGMENT NETWORK (Room to Room Network)
- 2.65 The segment network shall be a linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control
 - 2.65.1 Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network
 - 2.65.2 Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections
 - 2.65.3 The segment network shall utilize 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. The maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms
 - 2.65.4 Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device
 - 2.65.5 Substitution of manufacturer-supplied cable must be pre-approved: Manufacturer will not certify network reliability, and reserves the right to void warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements
 - 2.65.6 Segment networks shall be capable of connecting to BACnet-compliant BAS (provided by others) either directly, via MS/TP, or through NB-



ROUTERs, via BACnet/IP or BACnet/Ethernet. Systems whose roomconnected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable

2.66 WattStopper Product Number: LM-MSTP, LM-MSTP-DB

CONFIGURATION TOOLS

- 2.67 A wireless configuration tool facilitates optional customization of DLM local networks using two-way infrared communications, while PC software connects to each local network via a USB interface
- 2.68 Features and functionality of the wireless configuration tool shall include but not be limited to:
 - 2.68.1 Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet
 - 2.68.2 High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation
 - 2.68.3 Must be able to read and modify parameters for room controllers, occupancy sensors, wall switches, daylighting sensors, network bridges and relay panels, and identify room devices by type and serial number
 - 2.68.4 Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors
 - 2.68.5 Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings
 - 2.68.6 Adjust or fine-tune daylighting settings established during autoconfiguration, and input light level data to complete configuration of open loop daylighting controls
 - 2.68.7 Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings
 - 2.68.8 Verify status of building level network devices
- 2.69 WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

NETWORK BRIDGE

2.70 The network bridge module connects a DLM local network to a BACnetcompliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver

- 2.70.1 The network bridge shall be provided as a separate module connected on the local network through an available RJ-45 por
- 2.70.2 Provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network
- 2.70.3 The network bridge shall automatically create standard BACnet objects for selected room device parameters to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM room devices on each local network. BACnet objects will be created for the addition or replacement of any given in-room DLM device for the installed life of the system. Products requiring that an applicationspecific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - 2.70.3.1 Read/write the normal or after hours schedule state for the room
 - 2.70.3.2 Read the detection state of each occupancy sensor
 - 2.70.3.3 Read the aggregate occupancy state of the room
 - 2.70.3.4 Read/write the On/Off state of loads
 - 2.70.3.5 Read/write the dimmed light level of loads
 - 2.70.3.6 Read the button states of switches
 - 2.70.3.7 Read total current in amps, and total power in watts through the room control
 - 2.70.3.8 Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
 - 2.70.3.9 Activate a preset scene for the room
 - 2.70.3.10 Read/write daylight sensor fade time and day and night setpoints
 - 2.70.3.11 Read the current light level, in footcandles, from interior and exterior photosensors and photocells
 - 2.70.3.12 Set daylight sensor operating mode
 - 2.70.3.13 Read/write wall switch lock status

2.70.3.14	Read watts per square foot for the entire controlled room
2.70.3.15	Write maximum light level per load for demand response mode
2.70.3.16	Read/write activation of demand response mode for the room
2.70.3.17	Activate/restore demand response mode for the room

2.71 Wattstopper product number: LMBC-300

SEGMENT MANAGER

- 2.72 For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443)
- 2.73 Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the plans
- 2.74 Operational features of the Segment Manager shall include the following:
 - 2.74.1 Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic
 - 2.74.2 Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. Shall not require installation of any lighting control software to an end-user PC
 - 2.74.3 Log in security capable of restricting some users to view-only or other limited operations
 - 2.74.4 Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels
 - 2.74.5 After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the use

- 2.74.6 Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On
- 2.74.7 Ability to set up schedules for rooms and panels, view and override current status of panel channels and relays, and assign relays to groups. Schedules shall automatically set controlled zones or areas to either a normal hours or after hours mode of operation. Support for a minimum of 100 unique schedules, each with up to four time events per day. Support for annual schedules, holiday schedules and unique date-bound schedules
- 2.74.8 Ability to group rooms and loads for common control by schedules, switches or network commands
- 2.74.9 Ability to monitor connected load current and display power consumption for areas equipped with room controllers incorporating the integral current monitoring feature
- 2.74.10 Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control
- 2.74.11 The Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable
- 2.75 Segment Manager shall support multiple DLM rooms as follows
 - 2.75.1 Support up to 120 network bridges and 900 digital in-room devices (LMSM-3E)
 - 2.75.2 Support up to 300 network bridges and 2,200 digital in room devices, connected via network routers and switches (LMSM-6E)
- 2.76 WattStopper Product Numbers: LMSM-3E, LMSM-6E, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16

PROGRAMMING, CONFIGUARION AND DOCUMENTATION SOFTWARE

2.77 PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room

when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication. Additional parameters exposed through this method include but are not limited to:

- 2.77.1 Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
- 2.77.2 Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
- 2.77.3 Separate fade time adjustments per load for both normal and after hours from 0 4 hours.
- 2.77.4 Configurable occupancy sensor re-trigger grace period from 0 4 minutes separate for both normal hours and after hours.
- 2.77.5 Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
- 2.77.6 Load control polarity reversal so that on events turn loads off and vice versa.
- 2.77.7 Per-load DR (demand response) shed level in units of percent.
- 2.77.8 Load output pulse mode in increments of 1second.
- 2.77.9 Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer
- 2.78 Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
 - 2.78.1 Device list report: All devices in a project listed by type.
 - 2.78.2 Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
 - 2.78.3 BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
 - 2.78.4 Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.

- 2.78.5 Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.
- 2.78.6 Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100%, 2 = all loads 75%, 3 = all loads 50%, 4 = all loads 25%, 5-16 = same as scene 1).
- 2.78.7 Occupancy sensor report: Basic settings including time delay and sensitivity(ies) for all occupancy sensors
- 2.79 Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations
 - 2.79.1 Set, copy/paste an entire project site of sensor time delays.
 - 2.79.2 Set, copy/paste an entire project site of sensor sensitivity settings.
 - 2.79.3 Search based on room name and text labels.
 - 2.79.4 Filter by product type (i.e. LMRC-212) to allow parameter set by product.
 - 2.79.5 Filter by parameter value to search for product with specific configurations
- 2.80 Network-wide firmware upgrading remotely via the BACnet/IP network
 - 2.80.1 Mass firmware update of entire rooms
 - 2.80.2 Mass firmware update of specifically selected rooms or areas
 - 2.80.3 Mass firmware upgrade of specific products
- 2.81 WattStopper Product Number: LMCS-100, LMCI-100
- LMCP LIGHTING CONTROL PANELS
- 2.82 Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:
 - 2.82.1 Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 8 relays, 1 24 relays and 6 four-pole contactors, or 1 48 relays and 6 four-pole contactors
 - 2.82.2 Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel
 - 2.82.3 Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring

from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features

- 2.82.3.1 Removable, plug-in terminal blocks with connections for all low voltage terminations
- 2.82.3.2 Individual terminal block, override pushbutton, and LED status light for each relay
- 2.82.3.3 Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only
- 2.82.3.4 Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices
- 2.82.3.5 True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet
- 2.82.3.6 Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously
- 2.82.3.7 Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99
- 2.82.3.8 Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state
- 2.82.3.9 Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:

Electrical

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2.82.3.9.1	30 amp ballast at 277V
2.82.3.9.2	20 amp ballast at 347V
2.82.3.9.3	20 amp tungsten at 120V
2.82.3.9.4	30 amp resistive at 347V
2.82.3.9.5	1.5 HP motor at 120V
2.82.3.9.6	14,000 amp short circuit current rating (SCCR) at 347V
2.82.3.9.7	Relays shall be specifically UL 20 listed for control of plug-loads
Mechanical	
2.82.3.9.8	Replaceable, ¹ / ₂ " KO mounting with removable Class 2 wire harness

2.82.3.9.9 Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel

- 2.82.3.9.10 Dual line and load terminals each support two #14 - #12 solid or stranded conductors
- 2.82.3.9.11 Tested to 300,000 mechanical on/off cycles
- 2.83 Isolated low voltage contacts provide for true relay status feedback and pilot light indication
- 2.84 Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection
- 2.85 Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700
- 2.86 Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control
 - 2.86.1 Each panel shall include digital clock capability able to issue system wide automation commands to up to (11) eleven other panels for a total of (12) twelve networked lighting control panels. The clock shall provide

capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups

- 2.86.2 The clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes
- 2.86.3 The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for the clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed
- 2.86.4 The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
 - 2.86.4.1 Scheduled ON / OFF
 2.86.4.2 Manual ON / Scheduled OFF
 2.86.4.3 Astro ON / OFF (or Photo ON / OFF)
 2.86.4.4 Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
- 2.86.5 The user interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)
- 2.86.6 The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years
- 2.86.7 Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable
- 2.87 The lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection
- 2.88 The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet® protocol
 - 2.88.1 The panel shall have provision for an individual BACnet device ID and shall support the full 2^{22} range (0 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network

- 2.88.2 The panel shall support MS/TP MAC addresses in the range of 0 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second
- 2.88.3 Lighting control relays shall be controllable as binary output objects in the instance range of 1 64. The state of each relay shall be readable and writable by the BAS via the object present value property
- 2.88.4 Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 64
- 2.88.5 The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode
- 2.88.6 Setup and commissioning of the panel shall not require manufacturerspecific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
 - 2.88.6.1 Binary output objects in the instance range of 1 64 (one per relay) for on/off control of relays
 - 2.88.6.2 Binary value objects in the instance range of 1 99 (one per channel) for normal hours/after hours schedule control
 - 2.88.6.3 Binary input objects in the instance range of 1 64 (one per relay) for reading true on/off state of the relays
 - 2.88.6.4 Analog value objects in the instance range of 101 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches
- 2.88.7 The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel
- 2.88.8 The BO and BV 1 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (<u>http://www.bacnet.org/Addenda/Add-135-2010aa.pdf</u>)

- 2.88.9 Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object
- 2.88.10 Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196
- 2.89 WattStopper Product Number: LMCP8, LMCP24 or LMCP48

USER INTERFACE

- 2.90 Each lighting control panel system shall be supplied with at least (1) handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following panel-specific functions as a minimum:
 - 2.90.1 Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
 - 2.90.2 Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
 - 2.90.3 Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
 - 2.90.4 Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
 - 2.90.5 Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
 - 2.90.6 Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
 - 2.90.7 An additional handheld IR remote may optionally be specified to be permanently mounted to the panel interior via a retractable anti-theft



lanyard to allow for convenient programming of the panel while assuring that the handheld programmer is always present at that panel. An unlimited number of handheld IR remotes may also be purchased for facilities staff as determined by the end user's representative.

2.91 WattStopper Product Number: LMCT-100

EMERGENCY LIGHTING CONTROL DEVICES

2.92 Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

2.92.1 120/277 volts, 50/60 Hz, 20 amp ballast rating

- 2.92.2 Push to test button
- 2.92.3 Auxiliary contact for remote test or fire alarm system interface
- 2.93 WattStopper Product Numbers: ELCU-100, ELCU-200

PART 3 - EXECUTION

PRE-INSTALLATION MEETING

- 3.1 A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
 - 3.1.1 Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
 - 3.1.2 Review the specifications for low voltage control wiring and termination.
 - 3.1.3 Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 - 3.1.4 Discuss requirements for integration with other trades

CONTRACTOR INSTALLATOIN AND SERVICES

3.2 Contractor to install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs

- 3.3 Contractor to install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors. If pre-terminated cable is not used for room/area wiring, the contractor is responsible for testing each fieldterminated cable following installation, and shall supply the lighting controls manufacturers with test results. Contractor to install any room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty per DLM SEGMENT NETWORK section of specification. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings
- 3.4 Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication
- 3.5 Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings
 - 3.5.1 Adjust time delay so that controlled area remains lighted while occupied
- 3.6 Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - 3.6.1 Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 3.6.2 Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3.6.3 Load Parameters (e.g. blink warning, etc
- 3.7 Post start-up tuning After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report to the Architect / Owner of post start-up activity

FACTORY SERVICES

- 3.8 Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system
- 3.9 The electrical contractor shall provide both the manufacturer and the electrical engineer with three weeks written notice of the system start up and adjustment date
- 3.10 Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system

COMMISSIONING SUPPORT SERVICES

- 3.11 On this project, a commissioning agent will be hired to verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician's time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available. Manufacturer is NOT responsible for helping the commissioning agent inspect the individual devices. It will be the commissioning agent's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the agent with this task.
- 3.12 The commissioning agent shall work with the electrical contractor during installation of the lighting control hardware to become familiar with the specific products. The agent may also accompany the manufacturer's technicians during their start-up work to better understand the process of testing, calibration and configuration of the products. However, the contractor and manufacturer shall ensure that interfacing with the agent does not prevent them from completing the requirements outlined in the contract documents

ACCEPTANCE TESTING SUPPORT SERVICES

3.13 On all California projects, a certified lighting controls acceptance test technician (CLCATT) must verify the installation of the lighting control system. Manufacturer should include an extra day of factory technician's time to assist the CLCATT review the functionality and settings of the lighting control hardware per the requirements in the California State forms. It will be the CLCATT's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the CLCATT with this task

END OF SECTION

SECTION 26 22 13

DRY TYPE TRANSFORMERS

PART 1 – GENERAL

- 1.1 Furnish and install where indicated on the drawings dry type transformers with voltage and phase as shown on the drawings. The transformers shall be 60 Hz with KVA rating as shown on the drawings.
- 1.2 Submit shop drawings and manufacturer's data for each transformer including:
 - 1.2.1 Incident energy level calculations
- 1.3 Common submittal mistakes which will result in the submittal being rejected:
 - 1.3.1 Not including all items listed in the above itemized description.
 - 1.3.2 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.
 - 1.3.3 Not including actual manufacturer's catalog information of proposed products.
 - 1.3.4 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements, or "to be determined later" statements. The products being submitted must be the products installed.

PART 2 – PRODUCTS

- 2.1 Acceptable manufacturers are Square D, Eaton-Cutler Hammer, Siemens or General Electric.
- 2.2 Equipment manufactured by any other manufacturers not specifically listed in Section 2.1 are <u>not</u> considered equal, or approved for use on this project.
- 2.3 Energy efficient transformers shall be provided in compliance with NEMA TP-1 and requirements as outlined in the California Code of Regulations, Title 20: Division 2, Chapter 4, Article 4, Sections 1601-1609: Appliance Efficiency Regulations and California Code of Regulations, Title 24: part 6, Subchapter 2, Sections 110-11: Building Standards. Transformers shall also meet the Class 1 Efficiency levels for distribution transformers specified in Table 4-2 of the National Electrical Association (NEMA) TP-102002, Guide for Determining Energy Efficiency for Distribution Transformers" The TP-1 efficiency rating will apply to both conventional transformers and K-rated transformers.
- 2.4 Transformers shall comply with the latest NEMA and ANSI standards.
- 2.5 Transformers shall be encased in a sheet steel enclosure. Ten (10) KVA and smaller shall be non-ventilated, and above 10 KVA shall be ventilated, self-



cooled. The core and coil assembly shall be completely isolated from the enclosure by means of neoprene rubber isolation pads or other acceptable vibration isolators. Transformers installed outdoors shall be provided with suitable rain shields and shall be UL listed for outdoor installation.

- 2.5.1 Fan cooled transformers will not be accepted.
- 2.6 Transformers shall have a 185EC insulation system and shall not exceed 115EC rise above a 40EC ambient under full load conditions.
- 2.7 Transformers shall be capable of operating at 100 PCT. for taps below normal. Transformers rated 30 KVA and larger shall be 6 - 2-1/2 PCT., four below, and two above normal.
- 2.8 Transformer cable termination compartment shall be rated at not more than 75 degrees C.
- 2.9 Transformers shall have aluminum windings.
- 2.10 Sound outputs of transformers shall not exceed the following levels, based on NEMA standard testing procedures:

KVA Rating	Decibel Sound Output
0-9	40
10 - 50	45
51 - 150	50
151 - 300	55
301 - 500	60

PART 3 - EXECUTION

- 3.1 Dry type transformers larger than 112.5KVA rating shall have a minimum of twelve inches clearance between transformer ventilation openings and adjacent structure. Transformer connections shall be made with flexible conduit.
- 3.2 All lugs shall be torque tested in the presence of the inspector of record.
- 3.3 Transformers shall be anchored to the structure to resist seismic activity in accordance with Zone 4 requirements. Provide a minimum of four (4) ½-inch diameter anchor bolts for floor or roof mounted transformers.
- 3.4 Transformers mounted on roofs shall be installed on a roof curb. All conduits shall enter the transformer enclosure within the curbed area.
- 3.5 Arc Flash and Shock Hazard
 - 3.5.1 The Contractor is to provide, and submit to the engineer for approval, incident energy level calculations as determined using the methodologies described in NFPA 70E or IEEE standard 1584-2002.

- 3.5.2 A warning label, as specified in the above standard, shall be placed on each switchboard, panelboard, and safety switch indicating the incident energy levels on the equipment to warn qualified personnel in accordance with NFPA 70E, section 110.16. Labels shall be laminated white micarta with black lettering on each. Letters shall be no less than 3/8" high.
- 3.5.3 The incident level calculations for each piece of equipment shall be given to the owner and maintained on file by the maintenance department.
- 3.5.4 The design goal is to minimize the incident energy to which a maintenance employee may be exposed.

END OF SECTION

SECTION 26 24 13

SWITCHBOARDS

PART 1 – GENERAL

- 1.1 Furnish and install service entrance and distribution switchboards as herein specified and as shown on the drawings. In order to establish the minimum acceptable quality and type of equipment described in this section, the switchboard was technically and dimensionally designed around "Square D." If other acceptable manufacturer products listed in 2.1 are used, it shall be the responsibility of the Contractor to verify the equipment will meet the requirements of the design, both technically and dimensionally.
- 1.2 All electrical materials and equipment shall be new, and of the type and quality specified: Listed by Underwriters' Laboratories, and bear their label, where standards have been established; in compliance with the applicable standards of CEC (NFPA 70), NFPA, ANSI, IEEE, IPCEA and NEMA. All components and equipment enclosures shall be manufactured by the same manufacturer.
- 1.3 SUBMITTALS
 - 1.3.1 Submit shop drawings and manufacturers' data on the switchboard and components including:
 - 1.3.1.1 Equipment elevation diagrams indicating the bussing configurations and ampere ratings.
 - 1.3.1.2 Coordination study and incident energy level calculations.
 - 1.3.1.3 Metering equipment
 - 1.3.1.4 Breakers or fused switches
 - 1.3.1.5 Surge Protective Device (SPD)

1.4 <u>Common submittal mistakes which will result in the submittals being</u> rejected:

- 1.4.1 Not including the Short Circuit and Coordination Study with the material submittals.
- 1.4.2 Not including all items listed in the above itemized description.
- 1.4.3 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.

- 1.4.4 Not including actual manufacturer's catalog information of proposed products.
- 1.4.5 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements, or "to be determined later" statements. The products being submitted must be the products installed.

PART 2 – PRODUCTS

- 2.1 MANUFACTURERS
 - 2.1.1 Acceptable manufacturers are:
 - 2.1.1.1 Siemens
 - 2.1.1.2 Eaton
 - 2.1.1.3 Square D
- 2.2 Equipment manufactured by any other manufacturers not specifically listed in Section 2.1, are <u>not</u> considered equal or approved for use on this project.
- 2.3 Switchboards shall be of the dead front, safety type with voltage and ampere capacity as indicated. Provide a 25% minimum tin plated aluminum ground bus running the full length of the switchboards. The neutral bus shall be **100**% rated throughout.
- 2.4 Where conductor sizes exceed the standard breaker lug wire range, or where multiple conductors per phase are required, the manufacturer shall provide the breaker with suitable lugs for terminating the specified conductors.
- 2.5 All bussing shall be tin plated aluminum and braced for a short circuit current of 100,000 RMS symmetrical amperes minimum, or as noted on the drawings. Horizontal and vertical bussing shall be 100% fully rated; not tapered unless otherwise noted on the drawings. All sections shall have full height bus.
- 2.6 The main circuit breaker (480 volt or 208 volt, 800 amp or larger) shall be a stored energy solid state trip insulated case type breaker and shall consist of a three-pole electrically and mechanically trip-free circuit breaker with inter-pole barriers, arc quenchers, manual stored-energy closing mechanism, mechanical push-button trip, position indicator, and equipped for fixed mounting in the switchboard section. Main breaker shall be <u>100%</u> rated and shall be sized as indicated on the drawings. Minimum short circuit interrupting rating shall be 65,000 ampere symmetrical for all breakers in the main switchboard or as indicated on the drawings. For main breakers rated 2,500 amps and larger this rating shall be increased to 100,000 amps, or as indicated on the drawings.

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- 2.6.1 The over current trip devices to be furnished with the main circuit breaker shall be of the three-phase construction and employ solid-state components in their design to afford combinations of long, short time, and instantaneous and ground fault characteristics (480 volt only) as specified. The circuit breaker and integral solid-state trip device shall be self-contained to include necessary power supply, transformers and tapped current level sensing transformers. An external source shall not be required to trip the circuit breaker under fault of overload conditions or to test the ground fault trip.
- 2.6.2 Field installed rating plug taps shall be provided.
- 2.6.3 Main breakers 400 amp and larger shall be solid state trip.
- 2.6.4 The main circuit breaker shall be provided with the following:
 - 2.6.4.1 Adjustable longtime delay element pickup.
 - 2.6.4.2 Adjustable short-time delay element pickup.
 - 2.6.4.3 The instantaneous trip element pickup shall be adjustable from 1.5 to 10 times the sensor setting or <u>none</u>.
- 2.6.5 The feeder circuit breakers (480 volt or 208 volt, 400 amp or larger) shall be solid state trip molded case type breakers. They shall consist of a three-pole electrically and mechanically trip-free circuit breakers with inter-pole barriers, arc quenchers, manual closing mechanism, position indicator, and equipped for fixed mounting in the switchboard section. The breakers shall be a minimum of <u>80%</u> rated, unless otherwise identified on the drawings and shall be sized as indicated on the drawings. Minimum short circuit interrupting rating shall be 65,000 ampere symmetrical or as indicated on the drawings.
 - 2.6.5.1 The overcurrent trip devices to be furnished with these circuit breakers shall be of the three-phase construction and employ solid-state components in their design to afford combinations of long, short time, and instantaneous and ground fault characteristics (480 volt only) as specified. The circuit breaker and integral solid-state trip device shall be self-contained to include necessary power supply, transformers and tapped current level sensing transformers. An external source shall not be required to trip the circuit breaker under fault of overload conditions or to test the ground fault trip.
 - 2.6.5.2 Field installed rating plug taps shall be provided as required.
 - 2.6.5.3 These circuit breakers shall be provided with the following:
- 2.6.5.3.1 Adjustable long-time delay element pickup.
- 2.6.5.3.2 Adjustable short-time delay element pickup.
- 2.6.5.3.3 The instantaneous trip element pickup shall be adjustable from 1.5 to 10 times the sensor setting.
- 2.6.5.3.4 Where the GFI function is required the settings shall be set at maximum levels.
- 2.7 Feeder breakers identified as 100% rating on the drawings may be molded case type below 1600 amp but 1600 amp and above shall be insulated case type. All breakers shall accept copper or aluminum conductors. Contractor must verify that the breaker can accept the possibility of aluminum conductors.
- 2.8 Circuit breakers less than 400 amps shall be molded case, trip free, quick-make, quick-break, thermal magnetic type, with handles clearly indicating rating and position-on, off, tripped.
- 2.9 Circuit breakers used in service entrance equipment, identified on the drawings shall have short circuit current ratings equal to the bracing and in no case smaller than 22,000 amperes RMS symmetrical.
- 2.10 The switchboard shall be manufactured to locate the utility company metering within the local utility company requirements, for maximum centerline height. This maximum height must include the 2-1/2" high (above finished grade) concrete housekeeping.
- 2.11 Provide a metal embossed nameplate adjacent to the switchboard rating, indicating the maximum short circuit current rating of the switchboard as determined by UL 891, September 30, 1982.
- 2.12 Where devices indicated are fusible type, fuses shall be Bussman or Littlefuse (no known equal).
- 2.13 Where a switchboard is indicated to be provided with an NEMA 3R (weatherproof) enclosure, the enclosure shall be manufactured to allow the equipment to mount flush against a vertical surface or wall. Rear roof equipment overhangs will not be permitted for weatherproof equipment.
- 2.14 Where auxiliary test kits or other devices are needed for setting breaker parameters they shall be supplied.

Service Entrance – Surge Protective Device

2.15 IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits

- 2.16 IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
- 2.17 IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
- 2.18 National Electrical Code: Article 285
- 2.19 UL 1283 Electromagnetic Interference Filters
- 2.20 SPD shall be UL 1449 labeled as Type 1 or Type 4 intended for Type 1 applications, verifiable at UL.com without need for external or supplemental over current controls. Every suppression component of every mode, including N-G, shall be protected by internal over current and thermal over temperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of the specification
- 2.21 SPD shall be factory installed integral to electrical distribution equipment
- 2.22 SPD shall be UL labeled with 20kA I-nominal (I-n)
- 2.23 SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR)
- 2.24 Standard Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems.
- 2.25 SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect
- 2.26 SPD shall meet or exceed the following criteria:
 - 2.26.1 MAXIMUM 7-Mode sure current capability per phase shall be 400kA for mountain and desert areas with over 5 lightning strikes per year.
 - 2.26.2 UL 1449 Third Edition Revisions; effective September 29, 2009 Voltage Protection Ratings shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>	<u>MCOV</u>
208Y/120	700V	700V	700V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

2.26.3 UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com)

	Allowable System Voltage Fluctuation	
System Voltage	(%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

- 2.27 SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of -50dB at 100 kHz
- 2.28 Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
- 2.29 SPD shall include a serviceable, replaceable module.
- 2.30 SPD shall be equipped with the following diagnostics:
 - 2.30.1 Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service Led
 - 2.30.2 Audible alarm with on/off silence function and diagnostic test function (excluding branch)
 - 2.30.3 Form C dry Contacts

No other test equipment shall be required for SPD monitoring or testing before or after installation.

2.30.4 SPD shall have a 10 year warranty

Short-Circuit and Coordination Studies

- 2.31 The contractor shall provide the following studies; a time current and complete short-circuit study, equipment-interrupting or withstand evaluation, and a protective-device coordination study as described below for the distribution system. The equipment study shall be included with the equipment submittals. The studies shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum-fault conditions shall be thoroughly covered in the study. The studies are to be reviewed by a Professional Engineer registered in the State of California.
 - 2.31.1 All studies shall be performed by "Emerson Electric" (858) 695-9551, MTA (858) 472-0193, or Terra Power Solutions (858) 380-8170. Studies performed by manufactures or other engineering or testing companies must submit qualifications for approval by Johnson Consulting Engineers, 7 days prior to bid for this project.

2.32 Short-Circuit Study 5015021-100 Palomar College Escondido – HVAC Lab 10.04.2018 ©JCE #18013

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- 2.32.1 The study shall be in accordance with applicable ANSI and IEEE standards.
- 2.32.2 The study input data shall include the short-circuit single- and threephase contributions from all sources, with the X/R ratio, the resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and all other applicable circuit parameters.
- 2.32.3 Short-circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
- 2.32.4 For the portions of a system utilizing medium- and high-voltage breakers, separate calculations shall be made for one-half cycle (close and latch) currents and interrupting currents. Calculations shall be for three-phase and phase-to-ground faults at each bus under consideration.
- 2.32.5 For the portions of a system utilizing low-voltage breakers (less than 1,000 volts), calculations shall be made for three-phase and phase-to-ground interrupting currents at each bus under consideration.
- 2.33 Equipment Evaluation Study
 - 2.33.1 An equipment evaluation study shall be performed to assure the adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short-circuit ratings of these devices with the maximum short-circuit momentary and interrupting duties. Series rating of over current protective devices shall be permitted to reduce the maximum available short circuit current to panelboard branch circuit breakers to no more than 10,000 amps symmetrical for the 120/208 volt system and 14,000 amps symmetrical for the 277/480 volt system.
- 2.34 Protective-Device Coordination Study
 - 2.34.1 A protective-device coordination study shall be performed to select or to verify the selection of power fuse ratings, protective-relay characteristics and settings, ratios, and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and settings. Time current curves are to be colored to clearly indicate coordination.
 - 2.34.2 The coordination study shall include all voltage classes of equipment from the source's incoming line protective device down to and including each motor control center and/or panelboard. The phase and ground over current protection shall be included as well as settings for all other

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adjustable protective devices. Ground fault settings are to, as a minimum coordinate with a downstream 50 amp branch circuit breaker.

- 2.34.3 Protective device selection and settings shall be in accordance with requirements of the National Electrical Code and the recommendations of the ANSI/IEEE Standard 399, as applicable.
- 2.35 Study Report
 - 2.35.1 The results of the power-system studies shall be summarized in a final report. The report shall include the following sections:
 - 2.35.1.1 Description, purpose, basis, and scope of the study and a single-line diagram of the portion of the power system which is included within the scope of study.
 - 2.35.1.2 Tabulations of circuit breaker, fuse, and other equipment ratings versus calculated short-circuit duties and commentary regarding same.
 - 2.35.1.3 Protective device coordination curves, with commentary.
 - 2.35.1.4 The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. A tabulation of the recommended power fuse selection shall be provided for all fuses in the system.
 - 2.35.1.5 Fault-current tabulations including a definition of terms and a guide for interpretation.
 - 2.35.1.6 The report must be submitted with the material submittal for the engineers approval.
- 2.36 Implementation
 - 2.36.1 The equipment manufacturer is to be responsible for providing over current devices which are in compliance with the results of the above study.

PART 3 – EXECUTION

- 3.1 Switchboard shall be provided with adequate lifting means and capable of being rolled or moved directly to the floor without the use of floor sills.
- 3.2 Switchboard installation shall be done in accordance with National Electrical Installation Standards (NECA 400-1998) for installing and maintaining switchboards.

- 3.3 Provide 2-1/2" concrete housekeeping pads for service entrance and distribution switchboards. For switchboards containing local utility company metering equipment, the concrete pad must be flush with the front edge of the switchboard enclosure.
- 3.4 Provide permanently affixed engraved nameplate stating UL listed fault current rating of switchboard assembly. Locate adjacent to the equipment nameplate on front of switchboard.
- 3.5 All lugs shall be torque tested in the presence of the inspector of record.
- 3.6 Arc Flash and Shock Hazard
 - 3.6.1 The Contractor is to provide, and submit to the engineer for approval, incident energy level calculations as determined using the methodologies described in NFPA 70E or IEEE standard 1584-2002.
 - 3.6.2 A warning label, as specified in the above standard, shall be placed on each switchboard, panelboard, and safety switch indicating the incident energy levels on the equipment to warn qualified personnel in accordance with NFPA 70E, section 110.16. Labels shall be laminated white micarta with black lettering on each. Letters shall be no less than 3/8" high. The label is not to identify the party performing the study but only the technical information needed.
 - 3.6.3 The incident level calculations for each piece of equipment shall be given to the owner and maintained on file by the maintenance department.
 - 3.6.4 The design goal is to minimize the incident energy to which a maintenance employee may be exposed.

SECTION 26 24 16

PANEL BOARDS

PART 1 – GENERAL

- 1.1 Furnish and install branch circuit panel boards as specified herein and as indicated on the drawings. Submit manufacturers' data on all items.
- 1.2 Submit manufacturers' data on all panel boards and components including:
 - 1.2.1 Enclosures and covers
 - 1.2.2 Breakers
 - 1.2.3 Surge Protective Device (SPD) equipment
 - 1.2.4 Incident energy level calculations
 - 1.2.5 Common submittal mistakes which will result in the submittals being rejected:
 - 1.2.5.1 Not arranging the circuit breakers in panels to match the orientations indicated on the drawings. In other words, if a 30 amp breaker is shown on the drawing in Space #2, this must be the location it appears on the submittal schedule. Standard factory arrangements will not be accepted.
 - 1.2.5.2 Not including all items listed in the above itemized description.
 - 1.2.5.3 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.
 - 1.2.5.4 Not including actual manufacturer's catalog information of proposed products.
 - 1.2.5.5 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements or "to be determined later" statements. The products being submitted must be the products installed.

PART 2 – PRODUCTS

2.1 The interrupting rating of circuit breakers shall be 10,000 amps for the 120/208 system and 14,000 amp for 277/480 volt systems. Refer to drawings for higher interrupting rating requirements. All components and equipment enclosures shall be manufactured by the same manufacturer. Circuit breakers shall be permitted to be series rated to limit the available fault current to no more than the above ratings.

- 2.2 All panels shall be fully bussed. Recessed panel enclosures shall be a maximum of 20" wide and 5-3/4" deep for all panels 600 amp rated and less.
- 2.3 All busses shall be tin-plated aluminum and shall be located in the rear of the panelboard cabinet. Individual circuit breakers shall be bolt on type and removable from the cabinet without disturbing the bussing in any way. All panel boards shall contain ground busses.
- 2.4 Panel covers shall be door in door style, with one lock. Door lock shall allow access to breakers only. Access to wireways without removal of cover shall be permitted by (non removable) screws behind the locked door. Panel cover shall be provided with full length piano hinge. All locks for all panels provided in this project shall be keyed alike.
- 2.5 Each panel shall have a two-column circuit index card set under glass or glass equivalent on the inside of the door. Each circuit shall be identified as to use and room or area. Areas shall be designated by room numbers. Room numbers shown on the drawings may change and contractor shall verify final room numbers with the architect prior to project completion.
- 2.6 Tandem mounted or wafer type breakers are not acceptable.
- 2.7 Multiple breakers shall have one common trip handle or be internally connected. Handle ties are not acceptable.
- 2.8 Breaker arrangements shown in the drawings shall be maintained. The circuit breakers in panels must match the orientations indicated on the drawings. In other words, if a 30 amp breaker is shown on the drawing in Space #2, this must be the location it appears on the submittal schedule. Standard factory arrangements will not be accepted.
- 2.9 Where conductor sizes exceed the standard breaker lug wire range, or where multiple conductors per phase are required, the panelboard manufacturer shall provide the breaker with suitable lugs for terminating the specified conductors.
- 2.10 Acceptable manufacturers are Square D, Eaton, Siemens or General Electric.
- 2.11 Equipment manufactured by any other manufacturers not specifically listed in Section 2.10 are <u>not</u> considered equal, or approved for use on this project.

Surge Protective Devise (SPD)

2.12 Surge Protective Device (SPD) panelboards, shall be provided with an integrated circuit breaker panelboard and parallel connected suppression / filter system in a single enclosure. The SPD panelboard shall meet the following parameters: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, UL 1283 and the UL 1449, Third Edition, effective September 29, 2009.

- 2.13 The panelboard shall be UL 67 Listed and the SPD shall be UL 1449 labeled as Type 1 or Type 2 or as Type 4 intended for Type 1 or Type 2 applications. SPD shall be factory installed integral to the panel board.
- 2.14 The SPD panelboard shall be top or bottom feed according to requirements. A circuit directory shall be located inside the door.
- 2.15 SPD shall meet or exceed the following criteria:
 - 2.15.1 For standard areas supply SPD having 100kA per phase surge current capacity. For mountain and desert areas (areas with over 5 lightning strikes per year), SPD shall have a per phase surge current capacity of 200kA.
 - 2.15.2 UL 1449 Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>	<u>MCOV</u>
208Y/120	700V	700V	700V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

- 2.15.3 SPD shall be UL labeled with 100kA Short Circuit Current Rating (SCCR).
- 2.16 UL 1449 Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>	MCOV
208Y/120	700V	700V	700V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

- 2.17 SPD shall be UL labeled with a minimum 100kVA short circuit rated (SCCR).
- 2.18 UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

- 2.19 SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of 50dB at 100 kHz. No filtering is required for a 100kA SPD.
- 2.20 Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
- 2.21 Type 4 SPD shall include a serviceable, replaceable module.
- 2.22 SPD shall be equipped with the following diagnostics:

- 2.22.1 Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
- 2.22.2 No other test equipment shall be required for SPD monitoring or testing before or after installation.
- 2.23 SPD shall have a response time no greater than 1/2 nanosecond
- 2.24 SPD shall have a 10 year warranty
- 2.25 The SPD panelboard shall have removable interior
- 2.26 The SPD panelboard main bus shall be aluminum and rated for the load current required
- 2.27 The SPD panelboard shall include a 200% rated neutral assembly with copper neutral bus
- 2.28 The unit shall be provided with a safety ground bus

(SPD) Quality Assurance

- 2.29 Manufacturer Qualifications: Engage a firm with at least 5 years experience in manufacturing transient voltage surge suppressors.
- 2.30 Manufacturer shall be ISO 9001 or 9002 certified.
- 2.31 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- 2.32 The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

PART 3 – EXECUTION

- 3.1 Painting of panelboard covers in finished areas shall be done by the general contractor.
- 3.2 Provide a spare 3/4" conduit stubbed to an accessible area for each of every three (3) spares or spaces provided in recessed panel boards.
- 3.3 All lugs shall be torque tested in the presence of the inspector of record.

Arc Flash and Shock Hazard

3.4 The Contractor is to provide, and submit to the engineer for approval, incident energy level calculations as determined using the methodologies described in NFPA 70E or IEEE standard 1584-2002.

- 3.4.1 All studies shall be performed by "Emerson Electric" (858) 695-9551, MTA (858) 472-0193, or Terra Power Solutions (858) 380-8170. Studies performed by manufactures or other engineering or testing companies must submit qualifications for approval by Johnson Consulting Engineers, 7 days prior to bid for this project.
- 3.5 A warning label, as specified in the above standard, shall be placed on each switchboard, panelboard, and safety switch indicating the incident energy levels on the equipment to warn qualified personnel in accordance with NFPA 70E, section 110.16. Labels shall be laminated white micarta with black lettering on each. Letters shall be no less than 3/8" high.
- 3.6 The incident level calculations for each piece of equipment shall be given to the owner and maintained on file by the maintenance department
- 3.7 The design goal is to minimize the incident energy to which a maintenance employee may be exposed.

SECTION 26 27 26

SWITCHES AND RECEPTACLES

PART 1 – GENERAL

- 1.1 Furnish and install all wiring devices as shown on drawings and as herein specified. Unless otherwise noted, device and plate numbers shown are Hubbell and shall be considered the minimum standard acceptable. Other acceptable manufacturers are Pass and Seymour, Leviton, General Electric and Bryant.
- 1.2 Submit manufacturers' data on all items.

1.3 Common submittal mistakes which will result in the submittals being rejected:

- 1.3.1 Not correctly indicating ampacity rating of proposed devices.
- 1.3.2 Not including all items listed in the above itemized description.
- 1.3.3 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.
- 1.3.4 Not including actual manufacturer's catalog information of proposed products.
- 1.3.5 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements or "to be determined later" statements. The products being submitted must be the products installed.

PART 2 – PRODUCTS

2.1 All switches shall be of the quiet mechanical type, Specification Grade, 20 amp, 120/277 volt AC as follows:

	<u>HUBBELL</u>	LEVITON	PASS & SEYMOUR
Single Pole	CS120	CS1202	CS20AC1
Two Pole	CS1222	CS2202	CSB20AC2
Three-way	CS320	CS3202	CS20AC3
Key Switch	HBL1221L	1221-2L	PS20AC1-L

2.2 All switches shall have the "on" and the "off" position indicated on the handle. If switches of higher ampere ratings are required, they shall be of similar type and quality as those shown above. Groups of switches shown at one location shall be installed under a single plate up to a maximum of six where more than six switches are shown coordinate arrangement with the Architect.

- 2.3 Dimmer switches for incandescent lamp loads shall be square-law type, slide control dimmer with OFF position, Lutron or Hubbell "Nova-T" Series NT-600 (0-500 watt load), NT-1000 (501-900 watt load), NT-1500 (901-1500 watt load), or equal (no known equal).
- 2.4 All convenience receptacles and special outlets throughout shall be grounding type. Convenience receptacles shall be side wired, parallel slot, two pole, three wire, 20 amp as follows:

	<u>HUBBELL</u>	LEVITON	PASS & SEYMOUR
Duplex	5352	5362	PS5362
GFCI	GFR5362	7899	2097
Isolated Ground	IG5362	5362IG	IG6300
Tamper Proof		8300SG	TR63H

- 2.5 All safety or tamper proof receptacles shall have no exposed external current carrying metal parts, and shall have integral wiring leads suitable for two or three wire installations.
- 2.6 Special receptacles shall be as noted on the drawings.
- 2.7 Weatherproof plates shall be designed to meet CEC Article 410-57, wet location listed with cover "open." Where weatherproof receptacles have been identified to be provided with locking covers, the cover shall be as manufactured by Pass & Seymour #4600-8 or Cole Lighting 310 Series. Rough-in requirements vary between manufacturers. Contractor to field verify requirements prior to installation.
- 2.8 All plates throughout shall be stainless steel. Where wiring devices are installed in concrete block walls, provide oversized 3-1/2" x 5" coverplates.
- 2.9 All devices shall be white unless otherwise noted or a special purpose outlet.
- 2.10 Unless where specifically detailed on the drawings, floor boxes shall be PVC suitable for concrete poured floors of minimum 3-1/2" depth, with a modular design to gang two or three sections together.
 - 2.10.1 Carlon #E976 series or approved equal
 - 2.10.2 Provide brass cover with brass carpet flange unless otherwise detailed.

PART 3 – EXECUTION

- 3.1 Switches for room lighting shall be located no more than 12" center line from door jamb at plus 48" center line above finished floor or +46" to top of devices where located over casework, reference CBC Figure 11B-5D.
- 3.2 All receptacles shall be mounted at plus 18" to center line above finished floor unless noted or shown otherwise. All receptacles shall be installed with the ground pin up, at the top of the receptacle to comply with IEEE 602-1986.

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3.3 Furnish and install wall plates for all wiring devices, and outlet boxes, including special outlets, sound, communication, signal, and telephone outlets, etc. as required. All cover plates shall be appropriate for type of device.

SECTION 26 28 16

DISCONNECTS

PART 1 – GENERAL

- 1.1 Furnish and install all disconnect switches as shown on the drawings and as required by the CEC.
- 1.2 Submit manufacturers' data for all disconnects and fuses.
 - 1.2.1 Disconnects
 - 1.2.2 Fuses

1.3 Common submittal mistakes which will result in the submittals being rejected:

- 1.3.1 Not including all items listed in the above itemized description.
- 1.3.2 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.
- 1.3.3 Not including actual manufacturer's catalog information of proposed products.
- 1.3.4 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements, or "to be determined later" statements. The products being submitted must be the products installed.

PART 2 – PRODUCTS

- 2.1 Acceptable manufacturers shall be Square D, Cutler Hammer, Siemens or General Electric.
- 2.2 Equipment manufactured by any other manufacturers not specifically listed in Section 2.1 are <u>not</u> considered equal, or approved for use on this project.
- 2.3 All switches shall be heavy-duty type, externally operated, quick-make, quickbreak, rated 600 volts or 240 volts as required, with the number of poles and ampacity as noted. All switches for motors shall be HP rated. Switches shall have NEMA-Type 1 enclosures, except switches located where exposed to outdoor conditions shall have NEMA Type 3R enclosure. Switches generally shall be fused except where noted to be non-fused on the drawings.
- 2.4 Where fuses are indicated, fuses shall be Bussman or Littlefuse (no known equal). Fuses shall be current limiting type with time delay characteristics to suit the equipment served.

PART 3 - EXECUTION

- 3.1 Mount all switches to structure or U-channel support. U-channel supports shall be cleaned and painted to prevent rust.
- 3.2 Switches shall be accessible with proper clearances in front per CEC 110-16.
- 3.3 All lugs shall be torque tested in the presence of the inspector of record.
- 3.4 Arc Flash and Shock Hazard
 - 3.4.1 The contractor is to provide, and submit to the engineer for approval, incident energy level calculations as determined using the methodologies described in NFPA 70E or IEEE standard 1584-2002.
 - 3.4.2 A warning label, as specified in the above standard, shall be placed on each switchboard, panelboard, and safety switch indicating the incident energy levels on the equipment to warn qualified personnel in accordance with NFPA 70E, section 110.16. Labels shall be laminated white micarta with black lettering on each. Letters shall be no less than 3/8" high.
 - 3.4.3 The incident level calculations for each piece of equipment shall be given to the owner and maintained on file by the maintenance department.
 - 3.4.4 The design goal is to minimize the incident energy to which a maintenance employee may be exposed and in no case more than 8 cal./cm².

SECTION 26 51 14

LED LIGHTING FIXTURES AND LAMPS

PART 1 – GENERAL

- 1.1 Furnish and install all lighting fixtures with lamps as specified and as shown on the drawings. Fixtures shall be complete including canopies, hanger, diffusers, ballasts, etc.
- 1.2 Submit manufacturer's data for each fixture type including the following:
 - 1.2.1 Lighting fixture catalog data and photometry.
 - 1.2.2 Lamp catalog data for each fixture type.
 - 1.2.3 Driver catalog data for each fixture type.
 - 1.2.4 Fixture warranty.

1.3 <u>Common submittal mistakes which will result in the submittal being</u> <u>rejected:</u>

- 1.3.1 Not including lamp and driver information for each fixture type.
- 1.3.2 Not including all items listed in the above itemized description.
- 1.3.3 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.
- 1.3.4 Not including actual manufacturer's catalog information of proposed products.
- 1.3.5 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements, or "to be determined later" statements. The products being submitted must be the products installed.

PRODUCT SUBSTITUTION

- 1.4 All substitutions or alternate fixtures to those indicated on the project fixture schedule shall be submitted for approval (7) business days prior to the project bid date. Approvals <u>when</u> accepted will be issued in the form of an addendum. No consideration for substitutions will be provided after the award of the contract.
 - 1.4.1 The substitution request must include a statement indicating the difference in price of both the specified and alternate product, both contractor and list price. The substitution request must include a comparison of the total fixture wattage, total fixture lumens, fixture efficiency and warranty comparison.

1.4.2 When proposing to substitute lighting fixture and/or fixture retrofit, a point by point photometric calculation of a typical application as used in this project shall be included. A calculation of the specified and the proposed alternate shall be included.

PART 2 – PRODUCTS

- 2.1 All catalog numbers are given for manufacturer's identification and shall not relieve Contractor from responsibility of full conformance to all applicable written description requirements governing material and fabrication, either in the general or specific sections. Where catalog numbers are indicated as modified, no modification will be required if the standard unit fully conforms to descriptive requirements in the Specifications and matches specified ceiling.
- 2.2 All fixtures of the same type shall be of one manufacturer and of identical finish and appearance. All fixtures and component parts shall bear the UL label.
- 2.3 All steel parts shall be phosphate treated in multistage power spray system for corrosion resistance and paint adhesion. Final finish shall be electrostatically applied baked white enamel of not less than 87 pct. reflectance on reflecting surfaces.
- 2.4 Each fixture shall have a continuous light-seal gasket seated in such manner as to prevent any light leak through any portion or around any edge of the trim frame.
- 2.5 Diffusers shall be framed in a hinged, continuous assembly. Diffuser frame latches shall be spring-loaded or cam-operated.
- 2.6 All recessed fixtures shall be provided with frames appropriate for the type of ceiling involved. No fixtures shall be ordered until the ceiling construction has been verified by the Contractor.

MINIMUM LUMINARY REQUIREMENTS

- 2.7 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.
- 2.8 Recessed Fixtures: Comply with NEMA LE 4.
- 2.9 CRI of **minimum 80 CCT of 4100 K**.
- 2.10 Rated lamp life of 50,000 hours minimum.
- 2.11 Lamps dimmable from 100 percent to 0 percent of maximum light output.
- 2.12 Nominal Operating Voltage: **120 V / 277 V ac**
- PART 3 EXECUTION

- 3.1 All lighting fixtures shall be supported as follows:
 - 3.1.1 From the outlet box by means of a metal strap where its weight is less than five pounds.
 - 3.1.2 From its outlet box by means of a hickey or other threaded connection where its weight is from five to fifty pounds.
 - 3.1.3 Directly from the structural slab or joists where its weight exceeds fifty pounds.
 - 3.1.4 Lighting fixtures shall be supported independent of the ceiling system or additional ceiling support must be added to carry the weight of the lighting fixtures. Recessed lighting fixtures supported from ceiling grid tees shall be furnished with hold down clips in conformance with CEC 410 16, spring clips will not be permitted. All fixtures which the manufacturer has not provided UL approved clips, must be attached to the fixture and ceiling grid by metal screws.
- 3.2 Furnish and install supplementary blocking and support as required to support fixture from structural members. Contractor shall submit proposed blocking method for all suspended lighting fixtures for approval prior to rough in.
- 3.3 Suspended and/or pendant mounted fixtures shall be provided with four aircraft safety cables extending in opposite directions, attached to the fixture, and supported from a structural member. The contractor shall submit proposed fixture mounting and aircraft cable attachment methods for approval prior to fixture rough in.
- 3.4 Class 1 wiring to the fixture must be installed either conduit or type MC-PCS cabling no open wiring shall be permitted.
- 3.5 Chain suspension may be used only where specifically permitted on the drawings. Chain shall be heavy duty, nickel or cadmium plated, suitable for weight of specific fixture.
- 3.6 Shop drawings shall be furnished for each fixture type. Catalog cuts, illustrating conformance with specifications, will be acceptable for standard units. Shop drawings shall indicate materials, assembly, finish and dimensions.
- 3.7 Photometric data shall be furnished for any fixture substituted for those listed on the schedule.
- 3.8 Any driver which produces a greater than normal amount of noise shall be replaced by the contractor. Normal will be determined by the level of sound produced by other similar fixtures operating in the area.

SECTION 26 90 90

TESTING

PART 1 – GENERAL

- 1.1 Upon completion of the electrical work, the entire installation shall be tested by the Contractor, and demonstrated to be operating satisfactorily to the Architect, Engineer, Inspector and Owner.
- 1.2 All testing and corrections shall be made prior to demonstration of operation to the Architect, Engineer, Inspector and Owner.
- 1.3 In addition to the demonstration of operation, the Contractor is also required to review the content and quality of instructions provided on items demonstrated with the Architect, Engineer, Inspector and Owner.

PART 2 – EXECUTION

- 2.1 Wiring shall be tested for continuity, short circuits and/or accidental grounds. All systems shall be entirely free from "grounds," "short circuits," and any or all defects.
- 2.2 Motors shall be operating in proper rotations, and control devices functioning properly. Check all motor controllers to determine that properly sized overload devices are installed, and all other electrical equipment for proper operation.
- 2.3 Tests and adjustments shall be made prior to acceptance of the electrical installation by the Architect, and a certificate of inspection and acceptance of the electrical installation by local inspection authorities shall be provided.
- 2.4 All equipment or wiring provided which tests prove to be defective or operating improperly shall be corrected or replaced promptly, at no additional cost to the Owner.
- 2.5 Test all motor and feeder circuits with a "megger" tester to determine that insulation values conform to Section 110-20, California Electrical Code (CED). Test reports must be submitted and approved by the engineer before final acceptance.
- 2.6 Test all grounding electrode connections to assure a resistance of no more than 10 ohms is achieved. Augment grounding until the ohmic value stated above is achieved. Provide certified test results to the Architect, Engineer and Inspector.

SECTION 27 05 00

REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Provide a standard defining the structured communications cabling systems to be installed within customer facility. The goal is to accomplish this in the most economic and systematic fashion possible, and in a manner compliant with the latest codes, cabling standards and industry best practices.
 - 2. Scope of Work Compliance.
 - 3. Sub-contractor Qualifications.
 - 4. Warranty.
 - 5. Safety.
 - 6. Working Conditions.
- 1.02 GENERAL TERMS AND CONDITIONS.
 - A. General Contractor is responsible for all required Division 27 scope of work and shall ensure all communication sub-tier sub-contractors adhere to the qualifications set forth in all project Division 27 specifications including project experience and certifications.
 - B. Prices quoted shall be all-inclusive and represent a complete fully-engineered system installation at the Project site as contemplated by and detailed in the drawing package and in accompanying specifications.
 - C. Omissions in the specification of any provision herein described shall not be construed as to relieve the sub-contractor of any responsibility or obligation requisite to the complete and satisfactory delivery, installation, operation and support of any and all systems, equipment or services. Correction of any omission on the part of the Subcontractor, either due to misinterpretation of this specification or any other conditions of the project, shall be the responsibility of the Sub-contractor and shall not result in any contract modification or additional costs to Owner.
 - D. Where conflicts and/or irregularities occur between project documents, specifications, drawings, and/or applicable codes, rules, regulations, ordinances, standards, guidelines and practices, the more stringent requirement shall apply as reasonably determined by Owner or government agency inspector.
 - E. This specification represents the design intent for the project communicated by way of narrative descriptions of intended functionality and single line or detail drawings indicating likely equipment connectivity to achieve that functionality. The designs in this specification do not represent fully engineered technical solutions. Sub-contractors are required to review the designs presented in the project documents closely, submit any questions and clarifications regarding the design intent through the RFI process and develop their own engineered solutions representing a fully functional turn-key solution in their bid responses.

- F. The scope of this project includes the complete system engineering, procurement, fabrication, installation, programming, testing, training and warranty.
- G. Proposed solutions shall be based on the designs communicated in the specifications, but shall include any additional equipment, materials, software, licenses and/or labor required for the sub-contractor to deliver a fully functional turn-key system solution that meets intended operational performance requirements.
- H. It is the responsibility of the Sub-contractor awarded this project to ensure that all quantities, materials, labor, licenses, permits, sales taxes and any and all other costs to provide a turnkey project are included in their bid.
- I. Floor plans, drawings, elevation drawings, and other drawings received by the Subcontractor as part of the construction process are hereby incorporated into this document by reference. It is the responsibility of the Sub-contractor to ensure that amounts and lengths of cabling and pathways are correct, and that all materials and labor are included to install the system per the drawings and these specifications.
- J. Permits, licenses, applicable sales taxes, insurance requirements, payment/performance bond costs, and other miscellaneous costs are the responsibility of the Sub-contractor and must be included in the contract price and this scope of work. Such items are to be listed separately on pricing sheets, if provided. Copies of all required permits, licenses, insurance requirements and bond(s) are to be delivered to Owner prior to commencement of any work.
- K. Installation Schedule and Coordination: Sub-contractor must take the fast-track nature of this project and potential requirement for installation/work schedule adjustments and quick turnarounds into consideration in constructing this project as Owner will NOT entertain or agree to added-cost change orders associated with scheduling changes.
- L. Work will need to be closely coordinated with architect, College Personnel, GC, MEP sub-contractors, structural sub-contractor and all low-voltage sub-contractors and each of their respective schedules.
- M. This will be a turnkey Project. Any item of the equipment or material not specifically addressed on the drawings, specifications or elsewhere in Division 27 specifications documents, but required to provide complete and functional systems as contemplated and/or specified herein, shall be provided at no additional charge to owner in a quantity and quality consistent with other specified items.
- N. Coordination with Project Design Team: The build sub-contractor will be responsible for coordinating all communications cabling infrastructure requirements, including review of existing site conditions, review and coordination of electrical power and grounding requirements, conduits and back boxes, structural support requirements, and coordination.
- O. Assembly: The sub-contractor shall procure and assemble all hardware and equipment and any additional materials as required to deliver the completely functioning communications cabling system.

- P. Installation: The sub-contractor shall install all equipment, inter-rack and intra-rack cable, wiring of equipment, connectors, panels, plates, and other material at the Project site.
- Q. Testing and Adjustment: The sub-contractor shall perform all tests and adjustments, furnish all test equipment necessary and perform all work required to properly configure the systems and to verify their performance in accordance with the information in this document and the design-build integrator's approved engineered designs.
- R. Warranty: The sub-contractor shall warrant the installed system in accordance with the terms of this document and accompanying contractual documents.

1.03 RELATED DOCUMENTS

- A. All divisions of the specification and general provisions of the Construction Documents.
- B. Architectural, mechanical, electrical, and all technology drawings including but not limited to Telecommunication Drawings.
- C. Refer to Structural Seismic Requirement design documents Specifications, if available, for Non-Structural Components for all structural bracing and support of telecommunications equipment.

1.04 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. A/E: Architect / Engineer (designer)
 - 2. BICSI: Building Industry Consulting Service International
 - 3. EIA: Electronics Industry Alliance
 - 4. ELFEXT Equal Level far End Cross Talk
 - 5. FTP Foiled Twisted Pair
 - 6. IDF: Intermediate Distribution Facility
 - 7. ILEC/LEC: Incumbent Local Exchange Carrier
 - 8. ISP: Inside Plant
 - 9. IT: Information Technology
 - 10. MDF: Main Distribution Facility
 - 11. MPOE: Minimum Point of Entry
 - 12. NEXT Near End Cross Talk
 - 13. OSP: Outside Plant
 - 14. PSELFEXT: Power Sum Equal Level far End Cross Talk
 - 15. PSNEXT: Power Sum Near End Cross Talk
 - 16. RCDD: Registered Communications Distribution Designer
 - 17. TBD: To Be Determined
 - 18. TCIM: Telecommunication Cabling Installation Manual
 - 19. TDMM: Telecommunications Distribution Methods Manual
 - 20. TIA: Telecommunications Industry Association
 - 21. UTP: Unshielded Twisted Pair
 - 22. WAP: Wireless Access Point.

1.05 APPLICABLE REGULATORY REFERENCES

- A. Sub-contractor is responsible for knowledge and application of current versions of all applicable Standards and Codes. In cases where listed Standards and Codes have been updated, Sub-contractor shall adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.
 - 1. <u>ANSI/TIA:</u>
 - a. TIA-526-7 (OFSTP-7) (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. TIA-526-14-B (April 2015) (OFSTP-14) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - c. ANSI/TIA/EIA-598-C (July 2014) Optical Fiber Cable Color Coding
 - d. ANSI/TIA-568-C.0 (December 2015) Generic Telecommunications Cabling for Customer Premises
 - e. TIA-568-C.0-1 (September 2012) Generic Telecommunications Cabling for Customer Premises-Addendum 1, Updated Reference for Balanced Twisted-Pair Cabling
 - f. ANSI/TIA-568-C.1 (February 2012) Commercial Building Telecommunications Cabling Standards
 - g. TIA-568-C.1-2 (November 2014) Commercial Building Telecommunications Cabling Standard, Addendum 2 General Updates
 - h. ANSI/TIA-568-C.2 (June 2016) Balanced Twisted Pair Communications Cabling and Components Standards
 - i. ANSI/TIA-568-C.3 (June 2011) Optical Fiber Cabling Components Standard
 - j. ANSI/TIA-568-C.3-1 (December 2011) Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
 - k. ANSI/TIA-1183 (August 2012) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 - I. ANSI/TIA-1183-1 (January 2016) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Addendum 1 – Extending Frequency Capabilities to 2 GHz.
 - m. ANSI/TIA-568-C.4 (July 2011) Broadband Coaxial Cabling Components Standard
 - n. ANSI/TIA-942-A (August 2012) Telecommunications Infrastructure Standard for Data Centers
 - ANSI/TIA-942-A-1 (March 2013) Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
 - p. TIA-569-D (April 2015) Telecommunications Pathways and Spaces
 - q. TIA-569-D-1 (October 2016) Telecommunications Pathways and Spaces Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
 - r. ANSI/TIA-606-B (December 2015) Administration Standard for Telecommunications Infrastructure
 - s. TIA-607-B (November 2015) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises

- t. TIA-607-B-1 (January 2017) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises - External Grounding Addendum
- u. TIA-758-B (April 2012) Customer-Owned Outside Plant Telecommunication Infrastructure Standard
- v. TIA-1152 (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
- w. ANSI/TIA-862-B (February 2016) Structured Cabling Infrastructure Standard for Intelligent Building Systems.
- x. TIA-570-C (August 2012) Residential Telecommunications Infrastructure Standard
- y. TIA-1005-A (June 2012) Industrial Telecommunications Infrastructure Standard for Manufacturing, Process & Refining
- z. ANSI/TIA-1005 (January 2015) Telecommunications Infrastructure Standard for Industrial Premises
- aa. TIA-1005-1 (May 2012) Telecommunications Infrastructure Standard for Industrial Premises; Addendum 1 - Industrial Pathways and Spaces
- bb. TIA-1179 (July 2010) Healthcare Facility Telecommunications Infrastructure Standard.
- 2. ISO/IEC
 - a. ISO 11801 (November 2010) Generic Cabling for Customer Premises
 - b. ISO/IEC TR 14763-2-1:2012 Information technology -- Implementation and operation of customer premises cabling -- Part 2-1: Planning and installation Identifiers within administration system.
- 3. National Electric Codes
 - a. National Electrical Code (2017)
 - b. ANSI/NFPA 70-2017, National Electrical Code© (NEC©)
 - c. ANSI/IEEE C2-207, National Electrical Safety Code®
 - d. National Electrical Code (NEC) (NFPA 70)
- 4. OSHA Standards and Regulations all applicable
- 5. Local Codes and Standards all applicable
- 6. BICSI
 - a. Telecommunications Distribution Methods Manual, 13th Edition
 - b. BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - c. Information Technology Systems Installation Methods Manual (ITSIMM), 6th Edition
 - d. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001-2009, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. AV Design Reference Manual, 1st Edition
 - j. Network Design Reference Manual, 7th Edition
 - k. Outside Plant Design Reference Manual, 5th Edition
 - I. Wireless Design Reference Manual, 3rd Edition
 - m. Electronic Safety and Security Design Reference Manual, 3rd Edition.



- 7. Anywhere cabling Standards conflict with electrical or safety Codes, Subcontractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- 8. Knowledge and execution of applicable codes is the sole responsibility of the Subcontractor.
- 9. Any code violations committed at the time of installation shall be remedied at the Sub-contractor's expense.

1.06 SCOPE OF WORK

- A. General project information:
 - 1. These Specifications and associated drawings are the governing document for the installation of the telecommunications infrastructure and includes project descriptions, specified and recommended products, installation and project management methods, the scope of work and elevation drawing specifications.
 - 2. Through this division specification document, Palomar College will be referred to as the owner.
 - 3. The Contractor shall provide, install, test and warranty a complete turn-key Cable Infrastructure System for Owner's HVAC Lab, the "Project" per the scope of work and specifications stated herein. This inquiry implies no obligation on the part of Owner. The Contractor shall bear all costs and expenses incurred in preparing a response a Request For Proposal ("RFP") and subsequent award of project, it being understood and agreed that Owner accepts no responsibility for any costs and/or expenses incurred by winning sub-contractor in preparing and submitting such response.
 - 4. The scope of work will include providing and installing Category 6A cable infrastructure as required.
 - 5. Station cable pathway will consist of cable J-hook in accessible ceilings areas and conduit sleeve to accessible ceiling area.
 - 6. Communication Outlet (Split delta) w/# =In areas where cable will be installed in non-exposed format, contractor shall provide 5" square deep Randl junction box inside wall with single gang plaster ring and 1.25" conduit routed to accessible ceiling space. Cabling shall be run to the nearest TR. Outlet shall be mounted + 18" AFF (U.N.O.) Each outlet shall have a category 6A, 4-pair cables and a category 6, RJ-45 jacks per the number indicated on the drawings. (4=4 cables/Jacks) Jacks shall be housed in a standard angled four port single gang wall faceplate with matching blanks for unused ports. Color to match the wall paint color as close as possible. Wall plate color will be approved by architect prior to installation of faceplate.
 - 7. Installation of Copper UTP Category 6A cabling as indicated on drawings.
 - 8. Provide category patch cables and copper cross connections for both ends of communication link. Patch cable installation will be part of this scope of work.
 - 9. Contractor shall provide/install fire caulk in all conduits with cable as required, UL listed rated fire system where applicable.
 - 10. Contractor shall label all new cable at both termination points. Cable bundles shall be labeled where ever it is accessible including origin/destination and system information.

B. Purpose:

1. This specification defines quality standards and practices common to all network cabling for HVAC Lab project. In addition, said project will have Requests for

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Proposals (RFP), associated drawings and requirements pertaining to their specific environments. Such collateral will be referred to in this document as "Project Specific Documentation" or simply "Construction Documents".

- 2. Voice and Data Networks encompass a broad spectrum of technologies and are distributed into project internal spaces. Installed cables will be used for Ethernet, high and low speed data applications, used in analog and digital voice, not to exclude other future Voice/Data technologies. This specification will include indoor/outdoor cable installations, telecommunications equipment hardware as well as routing and support infrastructure.
- 3. It is the responsibility of the installing sub-contractor to evaluate these general recommendations and adapt them effectively to actual projects. Sub-contractor is responsible for identifying and bringing to the attention of any design directions that may be in conflict or otherwise improved. All such conflict resolutions shall be in writing from A/E or owner.
- 4. Note that while many portions of this global specification are addressed to "The Sub-contractor", these requirements apply equally to anyone doing the network cabling and infrastructure work within, whether those persons are outside sub-contractors or persons directly employed by the owner.
- 5. Sub-contractor shall be solely responsible for all parts, labor, testing, documentation and all other associated processes and physical apparatus necessary to turn-over the completed system fully warranted and operational for acceptance by A/E.
- 6. This specification includes structured cabling design considerations, product specifications and installation guidelines for low-voltage network systems and associated infrastructure including, but not limited to:
 - a. Cabling Sub-system 1 Horizontal
 - 1) Category 6A cable
 - 2) Work area (equipment outlet) appliances and configuration
 - 3) Horizontal Pathways
 - 4) Copper Patching
 - b. Communications Labeling and Administration

1.07 SUB-CONTRACTOR QUALIFICATIONS

- A. General:
 - 1. Sub-contractor shall have at least 5 years of experience installing and testing structured cabling systems.
 - 2. Sub-contractor shall employ at least one BICSI Registered Communication Distribution Designer (RCDD), and the RCDD shall sign-off on all designs offered, including stamping the design with their current BICSI/RCDD stamp.
 - 3. Sub-contractor shall have the responsibility to obtain any of the necessary permits, licenses, and inspections required for the performance of data cable installations.
 - 4. Contactor shall be a current manufacturer Certified Installer certificate. A copy of corporate certificate must be included with quote.
 - 5. Sub-contractor shall have service facilities within 50 miles of project location.
 - 6. At least 75 percent of the technicians on the job must have a current manufacturer Certified Copper Technicians certificate to install manufacturer Copper Distribution Systems.

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- 7. At least 75 percent of the technicians installing any Fiber Distribution Systems must have a current manufacturer Certified Fiber Technicians certificate to install Fiber Distribution Systems.
- 8. The Telecommunications sub-contractor must provide a project manager to serve as the single point of contact to manage the installation, speak for the subcontractor and provide the following functions:
 - a. Initiate and coordinate tasks with the Construction Manager and others as specified by the project schedule.
 - b. Provide day to day direction and on-site supervision of Sub-contractor personnel.
 - c. Ensure conformance with all contract and warranty provisions.
 - d. Participate in weekly site project meetings.
 - e. This individual will remain project manager for the duration of the project. The sub-contractor may change Project Manager only with the written approval of A/E.
- B. References:
 - 1. Communications Sub-contractor shall provide with bid a list of three reference accounts where similar Data Cable and related migration/cutover equipment installation work was performed within the last year or twelve-month period.
- C. Insurance Requirements:
 - 1. Sub-contractor must be insured and shall provide with bid a Certificate of Indemnification, Certificate of Insurance, and meet all required insurance and licensing policies as specified by A/E Risk Management Division and any Federal, State, and local organization pertaining to data cable installation.
 - 2. Sub-contractor's vehicles brought onto project properties, shall comply with all requirements of all Federal, State, and local agencies. Vehicles shall meet current DOT, state and local, safety inspections where required.
- D. Termination of Services:
 - 1. Owner or A/E reserves the right to terminate the Communication Sub-contractor's services if at any time the A/E determines the Communication Sub-contractor is not fulfilling their responsibilities as defined within this document.
 - 2. Sub-contractor's appearance and work ethics shall be of a professional manner, dress shall be commensurate with work being performed.
 - 3. Dress displaying lewd or controversial innuendos will strictly be prohibited.
 - 4. Conduct on project property will be professional in nature.
 - 5. Any person in the Sub-contractor's employ working on a project considered by to be incompetent or disorderly, or for any other reason unsatisfactory or undesirable, such person shall be removed from work on the project.
 - 6. The Communications Sub-contractor shall be restricted from the premises and compensated for the percentage of work completed satisfactorily.
- E. Other Sub-Contractor Responsibilities
 - 1. Sub-contractor is responsible for the removal and disposal of all installation and construction debris created in the process of the job. All work areas will be cleaned at the conclusion of the workday and no tools or materials shall be left in a manner as to pose a safety hazard.

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- 2. Sub-contractor must remove all abandoned cable per Article 800 of the National Electrical Code and per TIA and BICSI standards, recycling these materials where possible. This is mandatory; Sub-contractors must consider this when placing bids.
- 3. Sub-contractor shall abide by the regulations set by A/E or Owner Security Department pertaining to access to and conduct while on project property and shall obey speed limits and parking regulations.

1.08 SYSTEM PERFORMANCE WARRANTY

- A. General
 - 1. Sub-contractor shall provide a manufacturer System Warranty on all copper permanent cabling links.
 - 2. This is a system performance warranty guaranteeing for a minimum of 20 years from acceptance that the installed system shall support all data link protocols for which that copper Category or fiber OS designation is engineered to support according to IEEE and TIA standards.
 - 3. The manufacturer System Warranty may be invoked only if the cabling channel links are comprised of manufacturer connectivity and approved by the manufacturer. Patch cords must be same manufacturer of cable.
 - 4. Upon acceptance of Warranty, manufacturer will mail a notification letter to the installer and a notification letter and warranty certificate to A/E.
- B. Sub-Contractor Warranty Obligations
 - 1. Installation firm must be a current manufacturer Certified Installer in good standing and shall include a copy of the company certification with the bid.
 - 2. Sub-contractor shall name a supervisor to serve on site as a liaison responsible to inspect and assure all terminations are compliant to factory methods taught in manufacturer Technician Certification Training and according to all Standards cited in the Regulatory References section of this document.
 - 3. Sub-contractor liaison shall have a current, up-to-date manufacturer Certified Technician certificate in both copper and fiber. Copies of the copper and fiber certificates of the manufacturer liaison shall be submitted with the bid.
 - 4. Sub-contractor agrees all components comprising active links shall be of the same copper Category or fiber OS/OM designation as the system being installed. Sub-contractor shall under no circumstances mix different Categories or OS classes of cable or termination devices (connectors) within the same link or system.
 - 5. Sub-contractor shall install all racking and support structures according to cited TIA Standards in such fashion as to maintain both Standards and Manufacturer recommendations for uniform support and protection, segregation of different cable types, maintenance of maximum pulling tensions, minimum bend radius, approved termination methods as well as adhering to industry accepted practices of good workmanship.
 - 6. Sub-contractor is responsible for understanding and submitting to manufacturer all documents required prior to project start to apply for this warranty. These include but are not limited to the project information form and SCS warranty agreement.
 - 7. Sub-contractor is responsible for understanding and submitting to manufacturer all documents required at project end. These include completed warranty forms, passing test reports and drawings of floor plans showing locations of links tested.
 - 8. Test results shall be delivered in the tester native format (not Excel) and represent the full test report. Summaries shall not be accepted. Contact manufacturer for a current list of approved testers, test leads and latest operating systems.

9. The Communications Sub-contractor will correct any problems and malfunctions that are warranty-related issues without additional charge for the entire warranty period. The warranty period shall commence following the acceptance of the project by A/E and written confirmation of Warranty from manufacturer.

1.09 SAFETY

- A. General
 - 1. All cabling work being performed on project property or under contract to Technology Department must comply with Rules for safe operations, any state or local safety regulations and meet the requirements of OSHA Safety and Health Standards. The sub-contractor Project Manager will maintain a copy of Rules for Safe Operations for reference. It is the responsibility of the Communications Sub-contractor to immediately correct any unsafe working practices on the part of sub-contractor personnel. Unsafe working environments or conditions created by sub-contractor personnel will be reported immediately to the Construction Manager.
 - 2. Any liability for correction of conditions created by the sub-contractor's personnel rests with the sub-contractor.
 - 3. The Communications Sub-contractor shall be solely and completely responsible for conditions of the job site (as pertaining to the materials and equipment specified), including safety of persons and property during performance of work.
 - 4. No act, service, drawing review or construction observance by any employee, representative or engineer may be construed as a review or approval of the adequacy of the Sub-contractor(s) safety measures, in, on, or near the construction site.

1.10 WORKING CONDITIONS

- A. Site Access
 - 1. All cable installations must be pre-approved by the Construction Manager to ensure that the necessary arrangements have been made for proper access to project sites.
 - 2. A twenty-four-hour prior notice shall be submitted to the Construction Manager for any work schedule changes.
 - 3. Communications Sub-contractor shall display badges or passes as mandated by project property Security Department Rules and Regulations.
- B. Scheduling
 - 1. Coordination of site surveys and the issue of project owner owned materials and equipment will be the responsibility of the Construction Manager. Once said equipment and materials are in the Sub-contractor's possession, it is the Sub-contractor's responsibility to safeguard the material and equipment from damage or theft.
 - 2. Information required by the Sub-contractor to price and complete a defined scope of work will be furnished to the Communications Sub-contractor by the A/E Project Manager in a Scope of Work document and at the time of the site survey (if necessary) and will be maintained by the Communications Sub-contractor until the completion of the job.
 - 3. It is the Sub-contractor's responsibility to begin work promptly according to the Start Dates and to complete work by the Proposed Completion Date listed on the Cable Run Request Form.

- 4. The Sub-contractor must notify the Construction Manager in writing of any delays; at that time, they shall come up with a mutually agreeable project schedule.
- 5. The Communications Sub-contractor will coordinate with the Construction Manager working hours and job site access issues.
- 6. The Communications Sub-contractor will coordinate with the Construction Manager to minimize outages to the existing systems.
- 7. Any service interruption required by the Communications Sub-contractor must be requested in writing, and scheduled with the Construction Manager.
- 8. The Communications Sub-contractor shall not proceed with the requested service interruption until written approval is granted by the Construction Manager.
- 9. All problems, and questions relating to a particular job, will be referred to the Construction Manager and no changes shall be made without his/her written approval.
- C. Harmony Clause
 - 1. Sub-contractor shall coordinate and work in harmony with other trades on the project as well as with A/E personnel.

1.11 COORDINATION

- A. Coordinate layout and installation of voice, data, and video communication cabling with other sub-contractors and equipment suppliers.
 - 1. Meet jointly with other sub-contractors, equipment suppliers, and representatives to exchange information and agree on details of equipment arrangements and installation interfaces.
 - 2. Record agreements reached in meetings and distribute to other participants.
 - 3. Adjust arrangements and locations of distribution frames, cross-connect and patch panels in equipment rooms and telecommunications rooms to accommodate and optimize arrangement and space requirements of voice and LAN equipment.
 - 4. When indicated on drawings, sub-contractor shall reuse existing copper backbone cables.
 - 5. Provide weekly progress reports and crew schedules to project representatives by 5:00 PM, Thursday of each project work week.

1.12 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - 2. Submit product cut sheets and a detailed list of components a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The sub-contractor-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original Product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.

- 1.13 Information & Communication Technology (ICT) components
 - A. The Contract Documents generally outline industry standard components to be installed as part of the project ICT installation requirements. Such identification is intended to be general in nature rather than exhaustive. All stated quantities are subject to validation by ICT Sub-contractor. ICT Sub-contractor is reminded that differences between estimated quantities and those reasonably derived based from the Contract Documents (as well as through bid conferences, job walks, addendums, and other distribution of information) shall be the responsibility of the ICT Sub-contractor. There shall be no additional cost incurred by Palomar College HVAC Lab project for not complying with the specifications and requirements of the Contract Documents.
 - B. Any variance from those components identified on the drawings and/or below shall be submitted to Palomar College HVAC Lab project representatives for approval prior to ordering and installation; the risk for all costs incurred by the ICT Sub-contractor for materials ordered prior to such written approval shall be borne entirely by the ICT Sub-contractor. Nonetheless, it is imperative that the ICT Sub-contractor determine the availability of necessary materials and propose equivalent substitutes as necessary to meet all installation milestones. Delays in ICT installations due to lack of product availability are unacceptable. As catalog numbers change frequently, the ICT Sub-contractor must verify all part numbers prior to ordering materials. Clarifications will be issued in response to written Requests for Information (RFI).
 - C. Throughout this specification, Dura-Line, Berk-Tek, Leviton, Chatsworth Products, Inc. and other manufacturers are cited. These citations are for the purpose of establishing quality, performance, warranty certification criteria and are campus standards.
- 1.14 DELIVERY AND STORAGE
 - A. ICT Sub-contractor shall provide a materials schedule prior to the start date of cable installation. Material schedule shall specify all material quantities and their delivery date for this project.
 - B. ICT Sub-contractor shall provide protection from weather, moisture, dirt, dust and other contaminants for telecommunications cabling and pathway equipment placed in storage.
- 1.15 INFORMATIONAL SUBMITTALS
 - A. Coordination Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of grounding and bonding components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual, drawn component for review and action by the A/E prior to installation.
 - B. Certificates:
 - 1. Submit management and installation team reference documentation verifying:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents and has



five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.

- b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents.
- C. Qualification Statements:
 - 1. The sub-contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.
- 1.16 CLOSEOUT SUBMITTALS
 - A. As-Built Drawings:
 - 1. Submit all as-built drawings in accordance with the general requirements of the construction documents.
 - 2. Submit as-built drawings a minimum of two (2) weeks after completion of all Division- 27 work for A/E and Owner reference.
 - 3. Communication sub-contractor to print, frame and mount approved as-built drawings in MPOE. Coordinate location with A/E.
- 1.17 QUALITY ASSURANCE
 - A. Qualifications Manufacturer
 - 1. Component manufactures shall be ISO 9001:2000 and offer products that are RoHS compliant.
 - B. Qualifications Installer:
 - 1. At a minimum, seventy-five percent (75%) of the onsite sub-contractor provided field technicians shall be factory certified within 12 months by the manufacturer of the selected telecommunications system components being installed. Proof of certification shall be available on site for review at all times for each field technician.
- PART 2 PRODUCTS (Not Applicable)
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
- 3.02 RE-INSTALLATION
 - A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components. Scheduling for re- installation work shall be coordinated, in writing, with the owner prior to beginning any re- installation work

3.03 CLOSEOUT ACTIVITIES

- A. Sub-contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
- B. Sub-contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner

SECTION 27 05 28

HANGER AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Provides specifications for non-continuous cable support components utilized to provide pathways support to telecommunications cables traveling outside cable trays, conduits, or other continuous cable supports.
 - 2. Non-continuous cable supports.
- 1.02 RELATED DOCUMENTS
 - A. All divisions of the specification and general provisions of the Construction Documents.
 - B. Architectural, mechanical, electrical, and all technology drawings.
 - C. Refer to Structural Seismic Requirement design documents Specifications, if available, for Non-Structural Components for all structural bracing and support of telecommunications equipment.
 - D. Refer to T drawing details and notes for component anchorage and bracing requirements.
- 1.03 REFERENCES
 - A. Abbreviations and Acronyms:
 - 1. A/E: Architect / Engineer (designer)
 - 2. AHJ: Authority Having Jurisdiction
 - 3. BICSI: Building Industry Consulting Service International
 - 4. EIA: Electronics Industry Alliance
 - 5. TDMM: Telecommunications Distribution Methods Manual
 - 6. TIA: Telecommunications Industry Association
 - 7. UL: Underwriters Laboratory
 - B. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.
 - 1. National Electric Safety Code (NESC) 2017
 - 2. National Fire Protection Association (NFPA)
 - 3. 2016 California Electrical Code
 - 4. 2016 California Building Code
 - 5. Local Municipal Codes

1.04 APPLICABLE REGULATORY REFERENCES

A. Sub-contractor is responsible for knowledge and application of current versions of all applicable Standards and Codes. In cases where listed Standards and Codes have

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been updated, Sub-contractor shall adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.

- 1. ANSI/TIA:
 - a. TIA-526-7 (OFSTP-7) (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. TIA-526-14-B (April 2015) (OFSTP-14) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - c. ANSI/TIA/EIA-598-C (July 2014) Optical Fiber Cable Color Coding
 - d. ANSI/TIA-568-C.0 (December 2015) Generic Telecommunications Cabling for Customer Premises
 - e. TIA-568-C.0-1 (September 2012) Generic Telecommunications Cabling for Customer Premises-Addendum 1, Updated Reference for Balanced Twisted-Pair Cabling
 - f. ANSI/TIA-568-C.1 (February 2012) Commercial Building Telecommunications Cabling Standards
 - g. TIA-568-C.1-2 (November 2014) Commercial Building Telecommunications Cabling Standard, Addendum 2 General Updates
 - h. ANSI/TIA-568-C.2 (June 2016) Balanced Twisted Pair Communications Cabling and Components Standards
 - i. ANSI/TIA-568-C.3 (June 2011) Optical Fiber Cabling Components Standard
 - j. ANSI/TIA-568-C.3-1 (December 2011) Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
 - k. ANSI/TIA-1183 (August 2012) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 - I. ANSI/TIA-1183-1 (January 2016) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Addendum 1 Extending Frequency Capabilities to 2 GHz.
 - m. ANSI/TIA-568-C.4 (July 2011) Broadband Coaxial Cabling Components Standard
 - n. ANSI/TIA-942-A (August 2012) Telecommunications Infrastructure Standard for Data Centers
 - ANSI/TIA-942-A-1 (March 2013) Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
 - p. TIA-569-D (April 2015) Telecommunications Pathways and Spaces
 - TIA-569-D-1 (October 2016) Telecommunications Pathways and Spaces Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
 - r. ANSI/TIA-606-B (December 2015) Administration Standard for Telecommunications Infrastructure
 - s. TIA-607-B (November 2015) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
 - t. TIA-607-B-1 (January 2017) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises - External Grounding Addendum
 - u. TIA-758-B (April 2012) Customer-Owned Outside Plant Telecommunication Infrastructure Standard
- v. TIA-1152 (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
- w. ANSI/TIA-862-B (February 2016) Structured Cabling Infrastructure Standard for Intelligent Building Systems.
- x. TIA-570-C (August 2012) Residential Telecommunications Infrastructure Standard
- y. TIA-1005-A (June 2012) Industrial Telecommunications Infrastructure Standard for Manufacturing, Process & Refining
- z. ANSI/TIA-1005 (January 2015) Telecommunications Infrastructure Standard for Industrial Premises
- aa. TIA-1005-1 (May 2012) Telecommunications Infrastructure Standard for Industrial Premises; Addendum 1 - Industrial Pathways and Spaces
- bb. TIA-1179 (July 2010) Healthcare Facility Telecommunications Infrastructure Standard.
- 2. ISO/IEC
 - a. ISO 11801 (November 2010) Generic Cabling for Customer Premises
 - b. ISO/IEC TR 14763-2-1:2011 Information technology -- Implementation and operation of customer premises cabling -- Part 2-1: Planning and installation - Identifiers within administration system.
- 3. National Electric Codes
 - a. National Electrical Code (2017)
 - b. ANSI/NFPA 70-2017, National Electrical Code© (NEC©)
 - c. ANSI/IEEE C2-207, National Electrical Safety Code®
 - d. National Electrical Code (NEC) (NFPA 70)
- 4. OSHA Standards and Regulations all applicable
- 5. Local Codes and Standards all applicable
- 6. BICSI
 - a. Telecommunications Distribution Methods Manual, 13th Edition
 - b. BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - c. Information Transport Systems Installation Methods Manual (ITSIMM), 6th Edition
 - d. ANSI/BICSI 002-2011, Data Center Design and Implementation Best Practices
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001-2009, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. AV Design Reference Manual, 1st Edition
 - j. Network Design Reference Manual, 7th Edition
 - k. Outside Plant Design Reference Manual, 5th Edition
 - I. Wireless Design Reference Manual, 3rd Edition
 - m. Electronic Safety and Security Design Reference Manual, 3rd Edition.
- 7. Anywhere cabling Standards conflict with electrical or safety Codes, Subcontractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- 8. Knowledge and execution of applicable codes is the sole responsibility of the Sub-contractor.

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9. Any code violations committed at the time of installation shall be remedied at the Sub-contractor's expense.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the architect. Any repairs or changes made necessary in the contract work, caused by the sub-contractor's neglect, shall be made by the sub-contractor at their own expense.
- B. Scheduling:
 - 1. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Manager.

1.06 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - Submit product cut sheets and a detailed list of components a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The sub-contractor-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original Product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of grounding and bonding components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual, drawn component for review and action by the A/E prior to installation.
- B. Certificates:
 - 1. Submit management and installation team reference documentation verifying:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents



and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.

- b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents
- C. Qualification Statements:
 - 1. The sub-contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.
- 1.08 CLOSEOUT SUBMITTALS
 - A. As-Built Drawings:
 - 1. Submit all as-built drawings in accordance with the general requirements of the construction documents.
 - 2. Submit as-built drawings a minimum of two (2) weeks after completion of all Division- 27 work for A/E and Owner reference:
- 1.09 QUALITY ASSURANCE
 - A. Qualifications Manufacturer
 - 1. Component manufactures shall be ISO 9001:2000 and offer products that are RoHS compliant.
 - B. Qualifications Installer:
 - 1. At a minimum, seventy-five percent (75%) of the onsite sub-contractor provided field technicians shall be factory certified within 12 months by the manufacturer of the selected telecommunications system components being installed. Proof of certification shall be available on site for review at all times for each field technician.

1.10 WARRANTY

- A. Warranty:
 - 1. Sub-contractor shall provide a 25 year System Warranty on all copper permanent cabling links.
 - 2. This is a system performance warranty guaranteeing for 25 years from acceptance that the installed system shall support all data link protocols for which that copper Category or fiber OM/OS designation is engineered to support according to IEEE and TIA standards.
 - 3. The System Warranty may be invoked only if the cabling channel links are comprised of approved cable infrastructure connectivity and approved cable. Patch cords must be manufactured by same approved cable and/or connectivity system.
 - 4. Upon acceptance of Warranty, manufacturer will mail a notification letter to the installer and a notification letter and warranty certificate to A/E.

PART 2 - PRODUCTS

2.01 NON-CONTINUOUS CABLE SUPPORTS

- A. Basis-of-Design Product: Subject to compliance with requirements:
 - 1. Erico Caddy CableCat Support System
 - 2. Cooper/BLine Cable Hook System
 - 3. CEAS Attachments Stiffy Series
 - 4. Or approved equal

B. Product Options:

- 1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirement.
 - a. Stiffy Series 200 with comfort cradle Low Voltage supports
 - b. Four inch (0'4") Cat64HPSWM2, two inch (0'2") J-Hook Supports Cat32HPSWM2
- C. Description:
 - 1. Non-continuous cable supports shall be available in multiple sizes, styles and materials. Rigid supports shall be equipped with flared edges and pre-configured bend radius controls.
 - 2. Provide drop wire supports and threaded rod assemblies in areas where structural mounting surfaces are non-functional or inaccessible.
 - 3. Support assemblies shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance UTP and optical fiber cables.
 - 4. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be reusable.
 - 5. Select approved non-continuous cable supports suitable for specific installation environments and/or air handling (plenum) spaces.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.02 INSTALLATION

- A. Process:
 - 1. Follow manufacturer's instructions and recommended industry standards and guidelines.
 - 2. The installed non-continuous support system must be an independent support structure for the voice/data communication system.
 - 3. Draping cables over other structures in the ceiling is unacceptable. Water pipes, ceiling grid, sprinkler system, electrical supports, air ducts or any other in-ceiling structure may not be used for cable support.

- 4. Sub-contractor installed supports shall be used to supplement the main cable support system when any cabling leaves the main support system or is unsupported for more than three and one half feet (3'-5'-0") feet.
- 5. Non-continuous supports shall be installed with rod stock or threaded rod secured to the slab above to support the telecommunications cable infrastructure parallel to the slab throughout the cable plant, unless site conditions dictate a non-parallel installation.
- 6. Cable must be routed to follow existing corridors and parallel or 90 degree angles from all walls and the cable tray whenever possible.
- 7. All pathways shall avoid electromagnetic interference (EMI). Cable that is distributed in partially-enclosed metallic pathways shall be routed with the following minimum clearances:
 - a. Four (4) feet from motors or transformers.
 - b. One (1) foot from conduit and cables used for electrical power and distribution.
 - c. Five (5) inches from fluorescent lighting.

3.03 RE-INSTALLATION

- A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components. Scheduling for re- installation work shall be coordinated, in writing, with the owner prior to beginning any re- installation work
- 3.04 CLOSEOUT ACTIVITIES
 - A. Sub-contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
 - B. Sub-contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner

END OF SECTION

SECTION 27 05 33

CONDUITS AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Provides specifications for conduit pathways, back boxes and pull box enclosures utilized for the distribution and housing of telecommunications cabling and components:
 - 2. Telecom EMT conduit and boxes
- 1.02 RELATED DOCUMENTS
 - A. All divisions of the specification and general provisions of the Construction Documents.
 - B. Architectural, mechanical, electrical, and all technology drawings.
 - C. Refer to Structural Seismic Requirement design documents Specifications, if available, for Non-Structural Components for all structural bracing and support of telecommunications equipment.
- 1.03 REFERENCES
 - A. Abbreviations and Acronyms:
 - 1. A/E: Architect / Engineer (designer)
 - 2. ANSI: American National Standards Institute
 - 3. AHJ: Authority Having Jurisdiction
 - 4. BICSI: Building Industry Consulting Service International
 - 5. EIA: Electronics Industry Alliance
 - 6. TDMM: Telecommunications Distribution Methods Manual
 - 7. TIA: Telecommunications Industry Association
 - 8. UL: Underwriters Laboratory
 - B. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.
 - 1. National Electric Safety Code (NESC) 2017
 - 2. National Fire
 - 3. Protection Association (NFPA)
 - 4. 2016 California Electrical Code
 - 5. 2016 California Building Code
 - 6. Local Municipal Codes

1.04 APPLICABLE REGULATORY REFERENCES

A. Sub-contractor is responsible for knowledge and application of current versions of all applicable Standards and Codes. In cases where listed Standards and Codes have been

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updated, Sub-contractor shall adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.

- 1. ANSI/TIA:
 - a. TIA-526-7 (OFSTP-7) (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. TIA-526-14-B (April 2015) (OFSTP-14) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - c. ANSI/TIA/EIA-598-C (July 2014) Optical Fiber Cable Color Coding
 - d. ANSI/TIA-568-C.0 (December 2015) Generic Telecommunications Cabling for Customer Premises
 - e. TIA-568-C.0-1 (September 2012) Generic Telecommunications Cabling for Customer Premises-Addendum 1, Updated Reference for Balanced Twisted-Pair Cabling
 - f. ANSI/TIA-568-C.1 (February 2012) Commercial Building Telecommunications Cabling Standards
 - g. TIA-568-C.1-2 (November 2014) Commercial Building Telecommunications Cabling Standard, Addendum 2 General Updates
 - h. ANSI/TIA-568-C.2 (June 2016) Balanced Twisted Pair Communications Cabling and Components Standards
 - i. ANSI/TIA-568-C.3 (June 2011) Optical Fiber Cabling Components Standard
 - j. ANSI/TIA-568-C.3-1 (December 2011) Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
 - k. ANSI/TIA-1183 (August 2012) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 - I. ANSI/TIA-1183-1 (January 2016) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Addendum 1 – Extending Frequency Capabilities to 2 GHz.
 - m. ANSI/TIA-568-C.4 (July 2011) Broadband Coaxial Cabling Components Standard
 - n. ANSI/TIA-942-A (August 2012) Telecommunications Infrastructure Standard for Data Centers
 - ANSI/TIA-942-A-1 (March 2013) Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
 - p. TIA-569-D (April 2015) Telecommunications Pathways and Spaces
 - q. TIA-569-D-1 (October 2016) Telecommunications Pathways and Spaces Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
 - r. ANSI/TIA-606-B (December 2015) Administration Standard for Telecommunications Infrastructure
 - s. TIA-607-B (November 2015) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
 - t. TIA-607-B-1 (January 2017) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises - External Grounding Addendum
 - u. TIA-758-B (April 2012) Customer-Owned Outside Plant Telecommunication Infrastructure Standard
 - v. TIA-1152 (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling

- w. ANSI/TIA-862-B (February 2016) Structured Cabling Infrastructure Standard for Intelligent Building Systems.
- x. TIA-570-C (August 2012) Residential Telecommunications Infrastructure Standard
- y. TIA-1005-A (June 2012) Industrial Telecommunications Infrastructure Standard for Manufacturing, Process & Refining
- z. ANSI/TIA-1005 (January 2015) Telecommunications Infrastructure Standard for Industrial Premises
- aa. TIA-1005-1 (May 2012) Telecommunications Infrastructure Standard for Industrial Premises; Addendum 1 - Industrial Pathways and Spaces
- bb. TIA-1179 (July 2010) Healthcare Facility Telecommunications Infrastructure Standard.
- 2. ISO/IEC
 - a. ISO 11801 (November 2010) Generic Cabling for Customer Premises
 - b. ISO/IEC TR 14763-2-1:2012 Information technology -- Implementation and operation of customer premises cabling -- Part 2-1: Planning and installation Identifiers within administration system.
- 3. National Electric Codes
 - a. National Electrical Code (2017)
 - b. ANSI/NFPA 70-2017, National Electrical Code© (NEC©)
 - c. ANSI/IEEE C2-207, National Electrical Safety Code®
 - d. National Electrical Code (NEC) (NFPA 70)
- 4. OSHA Standards and Regulations all applicable
- 5. Local Codes and Standards all applicable
- 6. BICSI
 - a. Telecommunications Distribution Methods Manual, 13th Edition
 - b. BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - c. Information Technology Systems Installation Methods Manual (ITSIMM), 6th Edition
 - d. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001-2009, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. AV Design Reference Manual, 1st Edition
 - j. Network Design Reference Manual, 7th Edition
 - k. Outside Plant Design Reference Manual, 5th Edition
 - I. Wireless Design Reference Manual, 3rd Edition
 - m. Electronic Safety and Security Design Reference Manual, 3rd Edition.
- 7. Anywhere cabling Standards conflict with electrical or safety Codes, Subcontractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- 8. Knowledge and execution of applicable codes is the sole responsibility of the Subcontractor.
- 9. Any code violations committed at the time of installation shall be remedied at the Sub-contractor's expense.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the architect. Any repairs or changes made necessary in the contract work, caused by the sub-contractor's neglect, shall be made by the sub-contractor at their own expense.
- B. Scheduling:
 - 1. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Manager.

1.06 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - 2. Submit product cut sheets and a detailed list of components a minimum of six (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The sub-contractor-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original Product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of six (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of grounding and bonding components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual, drawn component for review and action by the A/E prior to installation.

1.08 CLOSEOUT SUBMITTALS

- A. As-Built Drawings:
 - 1. Submit all as-built drawings in accordance with the general requirements of the construction documents.
 - 2. Submit as-built drawings a minimum of two (2) weeks after completion of all Division- 27 work for A/E and Owner reference:

PART 2 - PRODUCTS

2.01 CONDUIT AND BACKBOXES

- A. EMT conduit
 - 1. Wheatland Tube
 - 2. Appleton
 - 3. Crouse-Hinds
 - 4. Or equal.
- B. PVC conduit
 - 1. JM Eagle
 - 2. Electro Flex
 - 3. Or equal
- C. Pull boxes
 - 1. Hoffman Engineering Co,
 - 2. Or equal.
- D. Back Boxes
 - Randl Industries 5 Square Outlet Box- 2.875 Deep with Management

 Part Number T-55017

2.02 TELECOMMUNICATIONS CONDUIT AND BACKBOXES

- A. Electrical Metallic Galvanized Tubing and Fittings with natural finish for all conduits not exposed: ANSI C80.3 with compression-type fittings.
- B. Indoor Pull boxes: Galvanized steel, screw cover pull box. Grey polyester powder coat finish inside and out. NEMA Type 1. Pull boxes to be sized per NEC code to accommodate the number of EMT conduits as shown on Telecom drawings with adequate clearances, access and cable management space.
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
- 3.02 INSTALLATION
 - A. Pull boxes:
 - 1. Install Pull boxes in easily accessible locations.
 - 2. Install Horizontal cabling boxes immediately above suspended ceilings.
 - 3. A pull box should not be used in lieu of a bend.
 - 4. Conduits that enter the pull box from opposite ends with each other should be aligned.

Conduit	Pull box	Pull box	Pull box	Pull box Width
Trade				for Additional
Size	Width (in.)	Length (in.)	Depth (in.)	Conduit
1	4	16	3	2
1	6	20	3	3
1	8	27	4	4
2	8	36	4	5
2	10	42	5	6
3	12	48	5	6
3	12	54	6	6
4	15	60	8	8

5. For direct access to a box located above inaccessible ceilings provide a suitable,

marked, hinged access panel (or equivalent) in the ceiling. This access panel can also serve as the cover for the box.

- 6. Pull box sizing table:
- B. Back Boxes
 - Provide 4-11/16" H X 4-11/16" W X 2-1/8" D outlet back boxes at all telecom outlet locations shown on drawings. Provide (1) 1-1/4" conduit from back box to accessible ceiling space or telecom room or pull box except as otherwise noted. All connectors and couplings shall be zinc-plated steel set screw type. Die cast zinc fittings are not to be used. Provide bushing on ends of all conduits. Provide pull string in all conduits.
 - 2. Provide single gang plaster ring on all communications outlet back boxes, unless indicated otherwise.
 - 3. Provide bonding to cable tray pathways.
- C. Conduit support and bracing:
 - 1. Coordinate layout and installation of conduits and pull boxes with other trade conditions to ensure adequate clearances, access and cable management.
 - 2. Install and provide support for EMT conduits and pull boxes in accordance with the latest edition of the NEC code, as well as all state and local codes and requirements. Coordinate installation and location with existing conditions. Notify and get the Owners Representative approval before installing conduits and pull boxes where the location need to deviate from the contract documents.
 - 3. Install conduits above ceilings at height to provide access to pull. Install conduits and pull boxes level and square and at proper elevations. Ensure adequate clearances, access and cable management.
 - 4. Use fittings and support devices compatible with conduits and pull boxes and suitable for use and location. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four.
 - 5. Install individual and multiple trapeze hangers and riser clamps as necessary to support the conduits. Provide U-bolts, clamp attachments and other necessary hardware for hanger assemblies and for securing hanger rods and conduits. Space supports for conduits on maximum 10-foot centers.
 - 6. Provide and install expansion or deflection fittings for conduits runs at all instances at seismic or expansion joints to allow for movement in any direction.
- D. Conduit routing, bends and radius guidelines:

- 1. If the conduit has an internal diameter of 2 inches or less the bend radius must be at least 6 times the internal conduit diameter.
- 2. If the conduit has an internal diameter of more than 2 inches the bend radius must be at least 10 times the internal conduit diameter.
- 3. Conduit bends should be smooth, even, and free of kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation.
- 4. If a conduit run requires more than two 90 degree bends then provide a pull box between sections with two bends or less.
- 5. If a conduit run requires a reverse bend (between 100 degrees and 180 degrees) then insert a pull point or pull box at each bend having an angle from 100 degrees to 180 degrees.
- 6. Consider an offset as equivalent to a 90 degree bend.
- 7. A pullbox shall not be used as a 90 degree bend.
- 8. Achieve the best direct route with no bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
- 9. Contain no continuous sections longer than 100 ft.
- 10. For runs that total more than 100 ft. in length, pull points or pull boxes should be inserted so that no segment between points/boxes exceeds the 100 ft. limit.
- 11. Withstand the environment to which they will be exposed.
- 12. Conduits should not be routed through areas in which flammable material may be stored or over or adjacent to boilers, incinerators, hot-water lines and steam lines.
- 13. Keep conduits at least 6' away from parallel runs of steam, hot water pipes or mechanical ductwork.
- E. Conduit Terminations
 - 1. Join conduits with fittings designed and approved for the purpose. Make the joints tight without protruding lips that can snag cable pulling inside the conduits.
 - 2. Where conduits are terminated with locknuts and bushings align the conduit to enter squarely and install the locknuts with dished part against the box. Use two locknuts, one inside and one outside the box.
 - 3. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
 - 4. Conduits that enter a telecom room should terminate near the corners to allow for proper cable racking.
 - 5. Terminate conduits that protrude through the structural floor 3 inches above the surface.
 - 6. Maintain the integrity of all fire stop barriers for all floor or wall penetrations.
- F. Provide grounding and bonding for conduits and pull boxes as indicated by NEC code and instructed by manufacturer.
- G. Conduits shall be clearly labeled at both ends designating the opposite locations(s) served. The numbering scheme shall be room number plus a suffix to guarantee uniqueness, e.g., 143-1. Labeling must be machine generated.
- H. Conduit Protection:
 - 1. Remove burrs, dirt and construction debris from conduits and pull boxes.
 - 2. Conduits should be left capped for protection.
 - 3. Provide final protection and maintain conditions in a manner acceptable to the Owners Representative to ensure that coatings, finishes and pull boxes are without

damage or deterioration at completion. Repair damage to galvanized finishes with zinc-rich paint recommended by the manufacturer.

3.03 ACCEPTANCE

- A. All specified conduits and pull boxes indicated on the drawings and specifications shall be complete.
- B. Specified shop drawings and product submittals shall have been submitted for review and all review comments and deficiencies shall have been resolved. Final shop drawings and product submittals shall have been submitted, reviewed and found to meet the requirements of the specifications.
- C. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.
- D. Sub-contractor shall provide written notice of final completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Sub-contractor will be notified in writing.

3.04 RE-INSTALLATION

- A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components. Scheduling for re- installation work shall be coordinated, in writing, with the owner prior to beginning any re- installation work
- B. CLOSEOUT ACTIVITIES
- C. Sub-contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
- D. Sub-contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner

END OF SECTION

SECTION 27 05 53

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Provides specifications information for identification of the various components of the telecommunications infrastructure and pathway system.
 - 2. Labeling and identification.

1.02 RELATED DOCUMENTS

- A. All divisions of the specification and general provisions of the Construction Documents.
- B. Architectural, mechanical, electrical, and all technology drawings.
- C. Refer to Structural Seismic Requirement design documents Specifications, if available, for Non-Structural Components for all structural bracing and support of telecommunications equipment.

1.03 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ANSI American National Standards Institute
 - 2. BICSI: Building Industry Consulting Service International
 - 3. EIA: Electronics Industry Alliance
 - 4. IDF: Intermediate Distribution Facility
 - 5. MDF Main Distribution Facility
 - 6. RCDD: Registered Communications Distribution Designer
 - 7. TCIM: Telecommunication Cabling Installation Manual
 - 8. TDMM: Telecommunications Distribution Methods Manual
 - 9. TIA: Telecommunications Industry Association
- B. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.
 - 1. National Electric Safety Code (NESC) 2017
 - 2. National Fire Protection Association (NFPA)
 - 3. 2017 California Electrical Code
 - 4. 2017 California Building Code
 - 5. Local Municipal Codes.

1.04 APPLICABLE REGULATORY REFERENCES

A. Sub-contractor is responsible for knowledge and application of current versions of all applicable Standards and Codes. In cases where listed Standards and Codes have been updated, Sub-contractor shall adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.

- 1. ANSI/TIA:
 - a. TIA-526-7 (OFSTP-7) (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. TIA-526-14-B (April 2015) (OFSTP-14) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - c. ANSI/TIA/EIA-598-C (July 2014) Optical Fiber Cable Color Coding
 - d. ANSI/TIA-568-C.0 (December 2015) Generic Telecommunications Cabling for Customer Premises
 - e. TIA-568-C.0-1 (September 2012) Generic Telecommunications Cabling for Customer Premises-Addendum 1, Updated Reference for Balanced Twisted-Pair Cabling
 - f. ANSI/TIA-568-C.1 (February 2012) Commercial Building Telecommunications Cabling Standards
 - g. TIA-568-C.1-2 (November 2014) Commercial Building Telecommunications Cabling Standard, Addendum 2 General Updates
 - h. ANSI/TIA-568-C.2 (June 2016) Balanced Twisted Pair Communications Cabling and Components Standards
 - i. ANSI/TIA-568-C.3 (June 2011) Optical Fiber Cabling Components Standard
 - j. ANSI/TIA-568-C.3-1 (December 2011) Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
 - k. ANSI/TIA-1183 (August 2012) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 - I. ANSI/TIA-1183-1 (January 2016) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Addendum 1 – Extending Frequency Capabilities to 2 GHz.
 - m. ANSI/TIA-568-C.4 (July 2011) Broadband Coaxial Cabling Components Standard
 - n. ANSI/TIA-942-A (August 2012) Telecommunications Infrastructure Standard for Data Centers
 - ANSI/TIA-942-A-1 (March 2013) Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
 - p. TIA-569-D (April 2015) Telecommunications Pathways and Spaces
 - TIA-569-D-1 (October 2016) Telecommunications Pathways and Spaces Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
 - r. ANSI/TIA-606-B (December 2015) Administration Standard for Telecommunications Infrastructure
 - s. TIA-607-B (November 2015) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
 - t. TIA-607-B-1 (January 2017) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises - External Grounding Addendum
 - u. TIA-758-B (April 2012) Customer-Owned Outside Plant Telecommunication Infrastructure Standard
 - v. TIA-1152 (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - w. ANSI/TIA-862-B (February 2016) Structured Cabling Infrastructure Standard for Intelligent Building Systems.

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- x. TIA-570-C (August 2012) Residential Telecommunications Infrastructure Standard
- y. TIA-1005-A (June 2012) Industrial Telecommunications Infrastructure Standard for Manufacturing, Process & Refining
- z. ANSI/TIA-1005 (January 2015) Telecommunications Infrastructure Standard for Industrial Premises
- aa. TIA-1005-1 (May 2012) Telecommunications Infrastructure Standard for Industrial Premises; Addendum 1 - Industrial Pathways and Spaces
- bb. TIA-1179 (July 2010) Healthcare Facility Telecommunications Infrastructure Standard.
- 2. ISO/IEC
 - a. ISO 11801 (November 2010) Generic Cabling for Customer Premises
 - ISO/IEC TR 14763-2-1:2012 Information technology -- Implementation and operation of customer premises cabling -- Part 2-1: Planning and installation - Identifiers within administration system.
- 3. National Electric Codes
 - a. National Electrical Safety Code (2017)
 - b. ANSI/NFPA 70-2017, National Electrical Code© (NEC©)
 - c. ANSI/IEEE C2-207, National Electrical Safety Code®
 - d. National Electrical Code (NEC) (NFPA 70)
- 4. OSHA Standards and Regulations all applicable
- 5. Local Codes and Standards all applicable
- 6. BICSI
 - a. Telecommunications Distribution Methods Manual, 13th Edition
 - b. BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - c. Information Technology Systems Installation Methods Manual (ITSIMM), 6th Edition
 - d. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001-2009, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. AV Design Reference Manual, 1st Edition
 - j. Network Design Reference Manual, 7th Edition
 - k. Outside Plant Design Reference Manual, 5th Edition
 - I. Wireless Design Reference Manual, 3rd Edition
 - m. Electronic Safety and Security Design Reference Manual, 3rd Edition.
- 7. Anywhere cabling Standards conflict with electrical or safety Codes, Subcontractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- 8. Knowledge and execution of applicable codes is the sole responsibility of the Subcontractor.
- 9. Any code violations committed at the time of installation shall be remedied at the Sub-contractor's expense.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the architect. Any repairs or changes made necessary in the contract work, caused by the sub-contractor's neglect, shall be made by the sub-contractor at their own expense.
- B. Scheduling:
 - 1. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Manager.

1.06 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - 2. Submit product cut sheets and a detailed list of components a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The sub-contractor-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original Product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of grounding and bonding components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual, drawn component for review and action by the A/E prior to installation.
- B. Certificates:
 - 1. Submit management and installation team reference documentation verifying:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.

- b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents.
- C. Qualification Statements:
 - 1. The sub-contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.

1.08 CLOSEOUT SUBMITTALS

- A. As-Built Drawings:
 - 1. Submit all as-built drawings in accordance with the general requirements of the construction documents.
 - 2. Submit as-built drawings a minimum of two (2) weeks after completion of all Division- 27 work for A/E and Owner reference:
 - 3. Communication sub-contractor to print, frame and mount approved as-built drawings in MPOE. Coordinate location with A/E.
- 1.09 QUALITY ASSURANCE
 - A. Qualifications Manufacturer
 - 1. Component manufactures shall be ISO 9001:2000 and offer products that are RoHS compliant.
 - B. Qualifications Installer:
 - 1. At a minimum, seventy-five percent (75%) of the onsite sub-contractor provided field technicians shall be factory certified within 12 months by the manufacturer of the selected telecommunications system components being installed. Proof of certification shall be available on site for review at all times for each field technician.
- PART 2 PRODUCTS
- 2.01 IDENTIFICATION LABELS
 - A. Basis-of-Design Product: Subject to compliance with requirements:
 - 1. Leviton System
 - 2. Brady Label System
 - 3. Brother Label System
 - 4. Or approved equal
 - B. Product Options:
 - 1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirements.
 - C. Description:
 - 1. In new installations (Greenfield), Sub-contractor shall develop and submit for approval a labeling strategy based on the TIA 606-B Circuit Designation and Labeling Standard.
 - 2. All labels shall be machine-manufactured by a labeling machine. Handwritten labels will not be accepted for final labeling.
 - 3. The intention of the labeling scheme is to be TIA/EIA 606-B compliant.

- 4. It is the responsibility of the sub-contractor to acquire, understand, and utilize the owner's labeling scheme for all component of the voice data communications system.
- 5. It is the responsibility of the sub-contractor to provide labels sized to show the Owner's labeling scheme in readable font size while still matching the specified hardware identification dimensions.
- 6. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.
- D. Indoor Copper cables and grounding conductors:
 - 1. The cable sheaths shall be labeled with laser-printed polyester self-laminating wrap around labels sized to fit the Owner's labeling scheme in readable font size.
- E. Horizontal cable outlet housings and faceplates:
 - 1. Cable termination connectors at each position on the outlet housing shall be labeled with laser-printed polyester labels inserted into the outlet housing labeling window.
- F. Copper patch panels:
 - 1. The patch panels shall be labeled on the front and rear top left corner with a laserprinted polyester self-laminating label sequentially identifying the patch panel.
- G. Copper patch termination blocks:
 - 1. The termination blocks shall be labeled on the front rows with the termination block designation strip colored per the BICSI requirements identifying the copper cable pairs.
- H. Indoor Conduits and pullboxes:
 - 1. Each section of conduit shall be labeled on the outside facing and unobstructed view with a laser-printed polyester self-laminating label sequentially identifying the conduit and its origin and termination end (to and from).
 - 2. Each pullbox shall be labeled on the outside door panel facing and unobstructed view with a laser-printed polyester self-laminating label sequentially identifying the pullbox and building location.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
- 3.02 INSTALLATION
 - A. Process:
 - 1. The Owner-provided labeling scheme is intended to comply with TIA/EIA 606-B standard for labeling and administration of a cable plant. It is the responsibility of the sub-contractor to acquire, understand, and utilize the owner's labeling scheme for all component of the voice data communications system including, but not limited to:

- 2. Indoor Horizontal copper cables (Identify at both ends within 6-inches of termination).
- 3. Workstation outlets, faceplates and individual outlet connectors.
- 4. Termination panels.
- 5. Indoor conduit pathways and pullboxes.
- 6. Label each component with a specified label at an unobstructed view location and where it is accessible for administration.
- 3.03 RE-INSTALLATION
 - A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components. Scheduling for re- installation work shall be coordinated, in writing, with the owner prior to beginning any re- installation work.
- 3.04 CLOSEOUT ACTIVITIES
 - A. Sub-contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
 - B. Sub-contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION

SECTION 27 08 00

COMMISSIONING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Provides specifications information for identification of the various components of the telecommunications infrastructure and pathway system.
 - 2. Copper cable test device.
- 1.02 RELATED DOCUMENTS
 - A. All divisions of the specification and general provisions of the Construction Documents.
 - B. Architectural, mechanical, electrical, and all technology drawings.
- 1.03 REFERENCES
 - A. Abbreviations and Acronyms:
 - 1. ANSI: American National Standards Institute
 - 2. BICSI: Building Industry Consulting Service International
 - 3. EIA: Electronics Industry Alliance
 - 4. ELFEXT: Equal Level far End Cross Talk
 - 5. FOTP: Fiber Optic Test Procedure
 - 6. IT: Information Technology
 - 7. ISP: Inside Plant
 - 8. LOMMF: Laser Optimized Multimode Fiber
 - 9. MHz: Megahertz
 - 10. NEXT: Near End Cross Talk
 - 11. OSP: Outside Plant
 - 12. OTDR: Optical Time Domain Reflectometer
 - 13. PSELFEXT: Power Sum Equal Level far End Cross Talk
 - 14. PSNEXT: Power Sum Near End Cross Talk
 - 15. RCDD: Registered Communication Distribution Designer
 - 16. TCIM: Telecommunication Cabling Installation Manual
 - 17. TDMM: Telecommunication Distribution Methods Manual
 - 18. TDR: Time Domain Reflectometer
 - 19. TIA: Telecommunications Industry Association
 - 20. UL: Underwriters Laboratory
 - 21. WAP: Wireless Access Point.
 - B. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.
 - 1. National Electric Safety Code (NESC) 2017
 - 2. National Fire Protection Association (NFPA)
 - 3. 2016 California Electrical Code

- 4. 2016 California Building Code
- 5. Local Municipal Codes

1.04 APPLICABLE REGULATORY REFERENCES

- A. Sub-contractor is responsible for knowledge and application of current versions of all applicable Standards and Codes. In cases where listed Standards and Codes have been updated, Sub-contractor shall adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.
 - 1. ANSI/TIA:
 - a. TIA-526-7 (OFSTP-7) (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. TIA-526-14-B (April 2015) (OFSTP-14) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - c. ANSI/TIA/EIA-598-C (July 2014) Optical Fiber Cable Color Coding
 - d. ANSI/TIA-568-C.0 (December 2015) Generic Telecommunications Cabling for Customer Premises
 - e. TIA-568-C.0-1 (September 2012) Generic Telecommunications Cabling for Customer Premises-Addendum 1, Updated Reference for Balanced Twisted-Pair Cabling
 - f. ANSI/TIA-568-C.1 (February 2012) Commercial Building Telecommunications Cabling Standards
 - g. TIA-568-C.1-2 (November 2014) Commercial Building Telecommunications Cabling Standard, Addendum 2 General Updates
 - h. ANSI/TIA-568-C.2 (June 2016) Balanced Twisted Pair Communications Cabling and Components Standards
 - i. ANSI/TIA-568-C.3 (June 2011) Optical Fiber Cabling Components Standard
 - j. ANSI/TIA-568-C.3-1 (December 2011) Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
 - k. ANSI/TIA-1183 (August 2012) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 - I. ANSI/TIA-1183-1 (January 2016) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Addendum 1 – Extending Frequency Capabilities to 2 GHz.
 - m. ANSI/TIA-568-C.4 (July 2011) Broadband Coaxial Cabling Components Standard
 - n. ANSI/TIA-942-A (August 2012) Telecommunications Infrastructure Standard for Data Centers
 - ANSI/TIA-942-A-1 (March 2013) Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
 - p. TIA-569-D (April 2015) Telecommunications Pathways and Spaces
 - TIA-569-D-1 (October 2016) Telecommunications Pathways and Spaces Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
 - r. ANSI/TIA-606-B (December 2015) Administration Standard for Telecommunications Infrastructure
 - s. TIA-607-B (November 2015) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises

- t. TIA-607-B-1 (January 2017) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises - External Grounding Addendum
- u. TIA-758-B (April 2012) Customer-Owned Outside Plant Telecommunication Infrastructure Standard
- v. TIA-1152 (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
- w. ANSI/TIA-862-B (February 2016) Structured Cabling Infrastructure Standard for Intelligent Building Systems.
- x. TIA-570-C (August 2012) Residential Telecommunications Infrastructure Standard
- y. TIA-1005-A (June 2012) Industrial Telecommunications Infrastructure Standard for Manufacturing, Process & Refining
- z. ANSI/TIA-1005 (January 2015) Telecommunications Infrastructure Standard for Industrial Premises
- aa. TIA-1005-1 (May 2012) Telecommunications Infrastructure Standard for Industrial Premises; Addendum 1 - Industrial Pathways and Spaces
- bb. TIA-1179 (July 2010) Healthcare Facility Telecommunications Infrastructure Standard.
- 2. ISO/IEC
 - a. ISO 11801 (November 2010) Generic Cabling for Customer Premises
 - b. ISO/IEC TR 14763-2-1:2012 Information technology -- Implementation and operation of customer premises cabling -- Part 2-1: Planning and installation Identifiers within administration system.
- 3. National Electric Codes
 - a. National Electrical Code (2017)
 - b. ANSI/NFPA 70-2017, National Electrical Code© (NEC©)
 - c. ANSI/IEEE C2-207, National Electrical Safety Code®
 - d. National Electrical Code (NEC) (NFPA 70)
- 4. OSHA Standards and Regulations all applicable
- 5. Local Codes and Standards all applicable
- 6. BICSI
 - a. Telecommunications Distribution Methods Manual, 13th Edition
 - b. BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - c. Information Technology Systems Installation Methods Manual (ITSIMM), 6th Edition
 - d. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001-2009, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. AV Design Reference Manual, 1st Edition
 - j. Network Design Reference Manual, 7th Edition
 - k. Outside Plant Design Reference Manual, 5th Edition
 - I. Wireless Design Reference Manual, 3rd Edition
 - m. Electronic Safety and Security Design Reference Manual, 3rd Edition.



- 7. Anywhere cabling Standards conflict with electrical or safety Codes, Subcontractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- 8. Knowledge and execution of applicable codes is the sole responsibility of the Subcontractor.
- 9. Any code violations committed at the time of installation shall be remedied at the Sub-contractor's expense.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the architect. Any repairs or changes made necessary in the contract work, caused by the sub-contractor's neglect, shall be made by the sub-contractor at their own expense.
- B. Scheduling:
 - 1. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Manager.

1.06 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - 2. Submit product cut sheets and a detailed list of components a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The sub-contractor-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original Product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of grounding and bonding components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual, drawn component for review and action by the A/E prior to installation.

- B. Certificates:
 - 1. Submit management and installation team reference documentation verifying:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.
 - b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents
- C. Qualification Statements:
 - 1. The sub-contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.
- D. Test Instrument Submittals:
 - 1. All copper & fiber optic test instruments used on the site shall be capable of storing test data files and downloading these test results as data files. The copper cable number and fiber optic cable/strand number shall be used as the record identifier for each test.
 - 2. Submit the model number, serial number, manufacturer, last date of calibration/certification as well as a copy of the certificate for each copper & fiber optic test instruments used on the site prior to any testing.

1.08 CLOSEOUT SUBMITTALS

- A. Test and Evaluation Reports:
 - 1. A complete set of test results verifying the installed link and channel performance parameter results for all cable types shall be presented to the A/E and the Owner at least one (1) week before the placement of any active electronics in technology rooms and/or spaces. The test result submittal shall contain the following:
 - a. Testing, verification and documentation of all performance specification parameters for voice, data cables in all IT spaces. The trade sub-contractor shall identify the types of cable tester(s) and interface adapters used during testing and certification when presenting the results for each type of cable and each test procedure.
 - b. Verification and test results in both paper and electronic formats printed directly from the testing device software application. Paper results must be neatly presented in a three (3) ring binder and sectioned according to floor and cable type; ISP, Category-6A cables (workstation cables) must be divided into separate sections for each room. Electronic results must be presented on CD-Rom disc(s) in the testing device's native file type with a copy of the electronic software used to generate the test results.
 - c. Documentation indicating the last calibration/service record of each certification tester device.

1.09 QUALITY ASSURANCE

- A. Qualifications Manufacturer
 - 1. Component manufactures shall be ISO 9001:2000 and offer products that are RoHS compliant.

- B. Qualifications Installer:
 - 1. Seventy Five percent (75%) of the onsite sub-contractor-provided field technicians shall be factory certified within 12 months by the manufacturer of the selected telecommunications system testing components being used. Proof of certification shall be available on site for review at all times for each field technician.

PART 2 - PRODUCTS

- 2.01 COPPER CABLE TESTER
 - A. Basis-of-Design Product: Subject to compliance with requirements:
 1. Fluke
 - B. Product Options:
 - 1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirement.
 - a. Fluke DSX CableAnalyzer Series
 - C. Description:
 - 1. Must meet or exceed TIA Level IV compliant network cable-testing device certification by an independent laboratory, such as Intertek, for verification of high speed, TIA/EIA T568 compliant cables.
 - 2. Copper test equipment must be capable of certifying Category-3, Category-5e, Category-6 and Category-6A UTP links or channels independent of termination hardware configuration (RJ 45 port or 110-style) for each level of performance.
 - 3. Provide full 2-way Autotest of Category-3, 5E, 6 and 6A twisted pair links.
 - 4. All test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
 - D. Accessory Products:
 - 1. Interface Adapters
 - 2. TIA Category-3, 5E and 6(A): 100 ohm
 - 3. Category/Class E permanent link adapters for TIA Cat 3, 5E, 6 and 6A unshielded and shielded cables.
 - 4. DTX ten (10) Gigabit Kit

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
- B. Verify telecommunications cabling is installed and supported, terminated, mounted in an appropriate housing or terminated on the applicable component and labeled prior to certification testing and documentation.
- C. Verify certification tester universal interface adapters and manufacturer patch cords that enable permanent link verification are in new condition not indicating any twisting or kinking resulting from incorrect storage of the tester interface adapters.

3.02 TESTING

- A. Process:
 - 1. Certification test 100% of the installed cabling plant including all backbone and horizontal four (4) pair MTP copper and multi-pair UTP connections.
 - 2. Follow manufacturers' instructions and recommended industry standards and guidelines to complete all TIA/EIA 568-C testing procedures to verify performance levels.
 - 3. All testing will utilize industry standard Method B parameters.
 - 4. Follow manufacturer requirements for self-calibration procedures.
 - 5. Update tester software to show specific project information including but not limited to:
 - 6. Date and time of testing
 - 7. Project name
 - 8. Field technicians name
 - 9. Cable identification number
 - 10. Cable manufacturer, type and part number
- B. Repair:
 - 1. Any connections failing to meet referenced standards or more stringent performance requirements stated above, must be removed and replaced with connections that prove, in additional testing, to meet or exceed the performance standards set forth.
- 3.03 CLOSEOUT ACTIVITIES
 - A. Sub-contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
 - B. Sub-contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner

END OF SECTION

SECTION 27 11 16

ENCLOSURES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Provides specifications for telecommunications enclosure components utilized to house various telecommunications infrastructure components within technology distribution spaces.
- 1.02 RELATED DOCUMENTS
 - A. All divisions of the specification and general provisions of the Construction Documents.
 - B. Architectural, mechanical, electrical, and all technology drawings.
 - C. Refer to Structural Seismic Requirement design documents Specifications, if available, for Non-Structural Components for all structural bracing and support of telecommunications equipment.

1.03 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ANSI: American National Standards Institute
 - 2. A/E: Architect / Engineer (designer)
 - 3. BICSI: Building Industry Consulting Service International
 - 4. EIA: Electronics Industry Alliance
 - 5. IDF: Intermediate Distribution Facility
 - 6. MDF Main Distribution Facility
 - 7. RCDD: Registered Communications Distribution Designer
 - 8. TCIM: Telecommunication Cabling Installation Manual
 - 9. TDMM: Telecommunications Distribution Methods Manual
 - 10. TIA: Telecommunications Industry Association
- B. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.)
 - 1. National Electric Code (2017)
 - 2. National Fire Protection Association (NFPA)
 - 3. 2017 California Electrical Code
 - 4. 2017 California Building Code
 - 5. Local Municipal Codes

1.04 APPLICABLE REGULATORY REFERENCES

A. Sub-contractor is responsible for knowledge and application of current versions of all applicable Standards and Codes. In cases where listed Standards and Codes have

been updated, Sub-contractor shall adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.

- 1. ANSI/TIĂ:
 - a. TIA-526-7 (OFSTP-7) (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. TIA-526-14-B (April 2015) (OFSTP-14) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - c. ANSI/TIA/EIA-598-C (July 2014) Optical Fiber Cable Color Coding
 - d. ANSI/TIA-568-C.0 (December 2015) Generic Telecommunications Cabling for Customer Premises
 - e. TIA-568-C.0-1 (September 2012) Generic Telecommunications Cabling for Customer Premises-Addendum 1, Updated Reference for Balanced Twisted-Pair Cabling
 - f. ANSI/TIA-568-C.1 (February 2012) Commercial Building Telecommunications Cabling Standards
 - g. TIA-568-C.1-2 (November 2014) Commercial Building Telecommunications Cabling Standard, Addendum 2 General Updates
 - h. ANSI/TIA-568-C.2 (June 2016) Balanced Twisted Pair Communications Cabling and Components Standards
 - i. ANSI/TIA-568-C.3 (June 2011) Optical Fiber Cabling Components Standard
 - j. ANSI/TIA-568-C.3-1 (December 2011) Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
 - k. ANSI/TIA-1183 (August 2012) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 - I. ANSI/TIA-1183-1 (January 2016) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Addendum 1 – Extending Frequency Capabilities to 2 GHz.
 - m. ANSI/TIA-568-C.4 (July 2011) Broadband Coaxial Cabling Components Standard
 - n. ANSI/TIA-942-A (August 2012) Telecommunications Infrastructure Standard for Data Centers
 - ANSI/TIA-942-A-1 (March 2013) Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
 - p. TIA-569-D (April 2015) Telecommunications Pathways and Spaces
 - TIA-569-D-1 (October 2016) Telecommunications Pathways and Spaces Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
 - r. ANSI/TIA-606-B (December 2015) Administration Standard for Telecommunications Infrastructure
 - s. TIA-607-B (November 2015) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
 - t. TIA-607-B-1 (January 2017) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises - External Grounding Addendum
 - u. TIA-758-B (April 2012) Customer-Owned Outside Plant Telecommunication Infrastructure Standard
 - v. TIA-1152 (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling

- w. ANSI/TIA-862-B (February 2016) Structured Cabling Infrastructure Standard for Intelligent Building Systems.
- x. TIA-570-C (August 2012) Residential Telecommunications Infrastructure Standard
- y. TIA-1005-A (June 2012) Industrial Telecommunications Infrastructure Standard for Manufacturing, Process & Refining
- z. ANSI/TIA-1005 (January 2015) Telecommunications Infrastructure Standard for Industrial Premises
- aa. TIA-1005-1 (May 2012) Telecommunications Infrastructure Standard for Industrial Premises; Addendum 1 - Industrial Pathways and Spaces
- bb. TIA-1179 (July 2010) Healthcare Facility Telecommunications Infrastructure Standard.
- 2. ISO/IEC
 - a. ISO 11801 (November 2010) Generic Cabling for Customer Premises
 - b. ISO/IEC TR 14763-2-1:2012 Information technology -- Implementation and operation of customer premises cabling -- Part 2-1: Planning and installation - Identifiers within administration system.
- 3. National Electric Codes
 - a. National Electrical Code (2017)
 - b. ANSI/NFPA 70-2017, National Electrical Code© (NEC©)
 - c. ANSI/IEEE C2-207, National Electrical Safety Code®
 - d. National Electrical Code (NEC) (NFPA 70)
- 4. OSHA Standards and Regulations all applicable
- 5. Local Codes and Standards all applicable
- 6. BICSI
 - a. Telecommunications Distribution Methods Manual, 13th Edition
 - b. BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - c. Information Technology Systems Installation Methods Manual (ITSIMM), 6th Edition
 - d. ANSI/BICSI 002-2011, Data Center Design and Implementation Best Practices
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001-2009, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. AV Design Reference Manual, 1st Edition
 - j. Network Design Reference Manual, 7th Edition
 - k. Outside Plant Design Reference Manual, 5th Edition
 - I. Wireless Design Reference Manual, 3rd Edition
 - m. Electronic Safety and Security Design Reference Manual, 3rd Edition.
- 7. Anywhere cabling Standards conflict with electrical or safety Codes, Subcontractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- 8. Knowledge and execution of applicable codes is the sole responsibility of the Sub-contractor.
- 9. Any code violations committed at the time of installation shall be remedied at the Sub-contractor's expense.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the architect. Any repairs or changes made necessary in the contract work, caused by the sub-contractor's neglect, shall be made by the sub-contractor at their own expense.
- B. Scheduling:
 - 1. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Manager.

1.06 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - 2. Submit product cut sheets and a detailed list of components a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The sub-contractor-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original Product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of grounding and bonding components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual, drawn component for review and action by the A/E prior to installation.
- B. Certificates:
 - 1. Submit management and installation team reference documentation verifying:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.

- b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents
- C. Qualification Statements:
 - 1. The sub-contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.

1.08 CLOSEOUT SUBMITTALS

- A. As-Built Drawings:
 - 1. Submit all as-built drawings in accordance with the general requirements of the construction documents.
 - 2. Submit as-built drawings a minimum of two (2) weeks after completion of all Division- 27 work for A/E and Owner reference:
- 1.09 QUALITY ASSURANCE
 - A. Qualifications Manufacturer
 - 1. Component manufactures shall be ISO 9001:2000 and offer products that are RoHS compliant.
 - B. Qualifications Installer:
 - 1. At a minimum, seventy-five percent (75%) of the onsite sub-contractor provided field technicians shall be factory certified within 12 months by the manufacturer of the selected telecommunications system components being installed. Proof of certification shall be available on site for review at all times for each field technician.
- PART 2 PRODUCTS
- 2.01 SUSPENDED CEILING WIRELESS ACCESS POINT ENCLOSURES
 - A. Basis-of-Design Product: Subject to compliance with requirements:
 - 1. Oberon suspended ceiling mount
 - a. Part Number Model 1046-CC0AP3800
 - B. Product Options:
 - 1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirements.
 - C. Description:
 - 1. Economical locking ceiling mount designed specifically for aesthetic, secure mounting of the CISCO 3800i devices wireless access point.
 - 2. Performance: Designed to meet NEC300-22 and 300-23 for plenum installations. OSHPD approved OPA No. 1638.
 - 3. Construction: 18 ga. textured white powder coated steel flange, 16 ga. aluminum back box. Patent pending locking mechanism, keyed alike, secures AP into the ceiling mount.
 - 4. Size: 24 inches by 24 inches by 2-1/4 inches deep (610 mm by 610 mm by 57 mm).

1.

- 5. Includes (1) Dual Cable Egress Firestop Kit (1" trade size conduit connector, and firestop grommet)
- 2.02 OUTDOOR WIRELESS ACCESS POINT ENCLOSURES
 - A. Basis-of-Design Product: Subject to compliance with requirements:
 - Ventev/TerraWave Wall Mounted Enclosure
 - a. Part Number CV12106KO-ODO4T
 - b. UPC Number 729198536725
 - B. Product Options:
 - 1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirements.
 - C. Description:
 - 1. Assembled 12" x 10" x 6" NEMA 4X polycarbonate enclosure with a solid door and Key Lock includes mounting feet and 4- RPTNC leads with an integrated outdoor Omni Antenna attached at the bottom of the enclosure. The enclosure also comes with mounting feet for easy installation. Constructed from polycarbontate plastic, this enclosure is durable, extremely affordable and is the lightest weight enclosure solution TerraWave offers.
 - 2. RoHS compliant
 - 3. Back panel for CISCO device.
 - 4. Provide all required attachments for wall mounting on exterior of modular buildings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.02 INSTALLATION

- A. Process:
 - 1. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:
 - a. Electrical requirements (conduit installation and capacity).
 - b. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
 - c. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.03 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components. Scheduling for re- installation work shall be coordinated, in writing, with the owner prior to beginning any re- installation work.

3.04 CLOSEOUT ACTIVITIES

- A. Sub-contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
- B. Sub-contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION

SECTION 27 11 19

TERMINATION BLOCKS AND PATCH PANELS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Provides specifications for wall and rack/cabinet-mounted blocks, termination panels and patch panel components utilized to terminate various telecommunications infrastructure cabling and connectivity.
 - 2. Copper horizontal cabling Patch Panels.
- 1.02 RELATED DOCUMENTS
 - A. All divisions of the specification and general provisions of the Construction Documents.
 - B. Architectural, mechanical, electrical, and all technology drawings.

1.03 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ANSI: American National Standards Institute
 - 2. A/E: Architect / Engineer (designer)
 - 3. BICSI: Building Industry Consulting Service International
 - 4. EIA: Electronics Industry Alliance
 - 5. IDF: Intermediate Distribution Facility
 - 6. MDF Main Distribution Facility
 - 7. RCDD: Registered Communications Distribution Designer
 - 8. TCIM: Telecommunication Cabling Installation Manual
 - 9. TDMM: Telecommunications Distribution Methods Manual
 - 10. TIA: Telecommunications Industry Association
- B. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.)
 - 1. National Electric Code (2017)
 - 2. National Fire Protection Association (NFPA)
 - 3. 2016 California Electrical Code
 - 4. 2016 California Building Code
 - 5. Local Municipal Codes

1.04 APPLICABLE REGULATORY REFERENCES

- A. Sub-contractor is responsible for knowledge and application of current versions of all applicable Standards and Codes. In cases where listed Standards and Codes have been updated, Sub-contractor shall adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.
 - 1. ANSI/TIA:

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$HMC {\scriptstyle \mathsf{Architects}}$

- a. TIA-526-7 (OFSTP-7) (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
- b. TIA-526-14-B (April 2015) (OFSTP-14) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
- c. ANSI/TIA/EIA-598-C (July 2014) Optical Fiber Cable Color Coding
- d. ANSI/TIA-568-C.0 (December 2015) Generic Telecommunications Cabling for Customer Premises
- e. TIA-568-C.0-1 (September 2012) Generic Telecommunications Cabling for Customer Premises-Addendum 1, Updated Reference for Balanced Twisted-Pair Cabling
- f. ANSI/TIA-568-C.1 (February 2012) Commercial Building Telecommunications Cabling Standards
- g. TIA-568-C.1-2 (November 2014) Commercial Building Telecommunications Cabling Standard, Addendum 2 General Updates
- h. ANSI/TIA-568-C.2 (June 2016) Balanced Twisted Pair Communications Cabling and Components Standards
- i. ANSI/TIA-568-C.3 (June 2011) Optical Fiber Cabling Components Standard
- j. ANSI/TIA-568-C.3-1 (December 2011) Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
- k. ANSI/TIA-1183 (August 2012) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
- I. ANSI/TIA-1183-1 (January 2016) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Addendum 1 – Extending Frequency Capabilities to 2 GHz.
- m. ANSI/TIA-568-C.4 (July 2011) Broadband Coaxial Cabling Components Standard
- n. ANSI/TIA-942-A (August 2012) Telecommunications Infrastructure Standard for Data Centers
- ANSI/TIA-942-A-1 (March 2013) Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
- p. TIA-569-D (April 2015) Telecommunications Pathways and Spaces
- TIA-569-D-1 (October 2016) Telecommunications Pathways and Spaces Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
- r. ANSI/TIA-606-B (December 2015) Administration Standard for Telecommunications Infrastructure
- s. TIA-607-B (November 2015) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
- t. TIA-607-B-1 (January 2017) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises - External Grounding Addendum
- u. TIA-758-B (April 2012) Customer-Owned Outside Plant Telecommunication Infrastructure Standard
- v. TIA-1152 (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
- w. ANSI/TIA-862-B (February 2016) Structured Cabling Infrastructure Standard for Intelligent Building Systems.

TERMINATION BLOCKS AND PATCH PANELS

5015021-100 Palomar College Escondido - HVAC Lab 10.04.2018 FOR COMMUNICATIONS SYSTEMS
- x. TIA-570-C (August 2012) Residential Telecommunications Infrastructure Standard
- y. TIA-1005-A (June 2012) Industrial Telecommunications Infrastructure Standard for Manufacturing, Process & Refining
- z. ANSI/TIA-1005 (January 2015) Telecommunications Infrastructure Standard for Industrial Premises
- aa. TIA-1005-1 (May 2012) Telecommunications Infrastructure Standard for Industrial Premises; Addendum 1 - Industrial Pathways and Spaces
- bb. TIA-1179 (July 2010) Healthcare Facility Telecommunications Infrastructure Standard.
- 2. ISO/IEC
 - a. ISO 11801 (November 2010) Generic Cabling for Customer Premises
 - b. ISO/IEC TR 14763-2-1:2012 Information technology -- Implementation and operation of customer premises cabling -- Part 2-1: Planning and installation - Identifiers within administration system.
- 3. National Electric Codes
 - a. National Electrical Code (2017)
 - b. ANSI/NFPA 70-2017, National Electrical Code© (NEC©)
 - c. ANSI/IEEE C2-207, National Electrical Safety Code®
 - d. National Electrical Code (NEC) (NFPA 70)
- 4. OSHA Standards and Regulations all applicable
- 5. Local Codes and Standards all applicable
- 6. BICSI
 - a. Telecommunications Distribution Methods Manual, 13th Edition
 - b. BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - c. Information Technology Systems Installation Methods Manual (ITSIMM), 6th Edition
 - d. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001-2009, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. AV Design Reference Manual, 1st Edition
 - j. Network Design Reference Manual, 7th Edition
 - k. Outside Plant Design Reference Manual, 5th Edition
 - I. Wireless Design Reference Manual, 3rd Edition
 - m. Electronic Safety and Security Design Reference Manual, 3rd Edition.
- 7. Anywhere cabling Standards conflict with electrical or safety Codes, Subcontractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- 8. Knowledge and execution of applicable codes is the sole responsibility of the Sub-contractor.
- 9. Any code violations committed at the time of installation shall be remedied at the Sub-contractor's expense.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the architect. Any repairs or changes made necessary in the contract work, caused by the sub-contractor's neglect, shall be made by the sub-contractor at their own expense.
- B. Scheduling:
 - 1. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Manager.

1.06 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - 2. Submit product cut sheets and a detailed list of components a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The sub-contractor-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original Product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of grounding and bonding components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual, drawn component for review and action by the A/E prior to installation.
- B. Certificates:
 - 1. Submit management and installation team reference documentation verifying:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.

- b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents
- C. Qualification Statements:
 - 1. The sub-contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.

1.08 CLOSEOUT SUBMITTALS

- A. As-Built Drawings:
 - 1. Submit all as-built drawings in accordance with the general requirements of the construction documents.
 - 2. Submit as-built drawings a minimum of two (2) weeks after completion of all Division- 27 work for A/E and Owner reference:
- 1.09 QUALITY ASSURANCE
 - A. Qualifications Manufacturer
 - 1. Component manufactures shall be ISO 9001:2000 and offer products that are RoHS compliant.
 - B. Qualifications Installer:
 - 1. At a minimum, seventy-five percent (75%) of the onsite sub-contractor provided field technicians shall be factory certified within 12 months by the manufacturer of the selected telecommunications system components being installed. Proof of certification shall be available on site for review at all times for each field technician.
- PART 2 PRODUCTS

2.01 COPPER HORIZONTAL CABLING PATCH PANELS

- A. Manufacturer List:
 - 1. Leviton
 - a. Angled Category 6A 48 Port
 - 1) Part Number 6A587-U48
- B. Product Options:
 - 1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular requirements for each situation.
- C. Description:
 - 1. All angled patch panels are to be rack/cabinet mountable within industry standard TIA/EIA 19" mounting rails unless otherwise noted.
 - 2. All angled patch panels are to provide adequate space for individual port labeling on the front and cable/connector labeling on the back.
 - 3. All installed station cable patch panels shall be Category 6A forty-eight (48) port angled patch panels

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- 4. The performance criteria for the patch panels must meet or exceed the performance parameters for frequency, attenuation, near end cross-talk (NEXT), attenuation to cross-talk ratio (ACR), power sum NEXT (PS-NEXT), power sum ACR (PS-ACR), equal level far end cross-talk (ELFEXT), power sum far end cross-talk (PS-FEXT), and return loss (RL) as set forth in TIA/EIA 568-C category standards.
- D. Accessory Products:
 - 1. Provide any accessory products related to the patch panels to provide a complete and functional infrastructure system.
 - 2. Port RJ-45 jack block out device to safely secure access to unused ports and deter vandalism to jacks.
 - 3. Provide complete with all required mounting hardware and fittings and cables needed.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:
 - 1. Electrical requirements (conduit installation and capacity)
 - 2. The telecommunications rooms are the size shown on the project drawings.
 - 3. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
 - 4. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.02 INSTALLATION

- A. Process:
 - 1. Install all category copper termination panels/panels under the guidelines of the manufacturer's recommended instructions and per all TIA/EIA 568-C standards and manufacturer-approved industry practices as shown in the drawings.
 - 2. The installation and performance parameters of all installed cable termination panels shall be verified by the sub-contractor through TIA/EIA 568-C testing procedures.
 - 3. Label all cable termination panels to identify each port and each specific panel in accordance with the TIA/EIA 606 labeling scheme approved by the Owner.
- B. Installation description:
 - 1. Sub-contractor shall use existing cabling management pathways and take care to place cable like with like, maintaining original segregation strategies for separating fiber and copper cables as well as any separation necessary between different types of copper cables.
 - 2. Cables shall be dressed neatly within patch management pathways with care taken to maintain minimum bend radius of not less than 1 times the cord outer



diameter for copper and not less than a 1" bend radius for fiber jumpers as per ANSI/TIA 568-C.0

- 3. The installation and performance parameters of all installed cable termination panels shall be verified by the sub-contractor through TIA/EIA 568-C testing procedures.
- 4. Label all cable termination panels to identify each port and each specific panel in accordance with the TIA/EIA 606 labeling scheme approved by the Owner.

3.03 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components due to manufacturer defects or sub-contractor poor performance. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning any re- installation work.

3.04 CLOSEOUT ACTIVITIES

- A. Sub-contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
- B. Sub-contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner

END OF SECTION

SECTION 27 15 13

COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Provides specifications for four-pair UTP copper horizontal workstation cabling to distribute network signals from telecommunications distribution spaces to work area outlet locations.
 - 2. Category 6A CMP rated, Four-Pair Copper Cabling.
- 1.02 RELATED DOCUMENTS
 - A. All divisions of the specification and general provisions of the Construction Documents.
 - B. Architectural, mechanical, electrical, and all technology drawings.

1.03 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ANSI: American National Standards Institute
 - 2. A/E: Architect / Engineer (designer)
 - 3. BICSI: Building Industry Consulting Service International
 - 4. EIA: Electronics Industry Alliance
 - 5. IDF: Intermediate Distribution Facility
 - 6. LOMMF: Laser Optimized Multi-Mode Fiber
 - 7. MDF Main Distribution Facility
 - 8. NEXT: Near End Cross Talk
 - 9. OSP: Outside Plant
 - 10. PSELFEXT: Power Sum Equal Level Far End Cross Talk
 - 11. PSNEXT: Power Sum Near End Cross Talk
 - 12. RCDD: Registered Communications Distribution Designer
 - 13. TCIM: Telecommunication Cabling Installation Manual
 - 14. TDMM: Telecommunications Distribution Methods Manual
 - 15. TIA: Telecommunications Industry Association
- B. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.)
 - 1. National Electric Code (2017)
 - 2. National Fire Protection Association (NFPA)
 - 3. 2016 California Electrical Code
 - 4. 2016 California Building Code
 - 5. Local Municipal Codes

1.04 APPLICABLE REGULATORY REFERENCES

A. Sub-contractor is responsible for knowledge and application of current versions of all

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- 1. ANSI/TIĂ:
 - a. TIA-526-7 (OFSTP-7) (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. TIA-526-14-B (April 2015) (OFSTP-14) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - c. ANSI/TIA/EIA-598-C (July 2014) Optical Fiber Cable Color Coding
 - d. ANSI/TIA-568-C.0 (December 2015) Generic Telecommunications Cabling for Customer Premises
 - e. TIA-568-C.0-1 (September 2012) Generic Telecommunications Cabling for Customer Premises-Addendum 1, Updated Reference for Balanced Twisted-Pair Cabling
 - f. ANSI/TIA-568-C.1 (February 2012) Commercial Building Telecommunications Cabling Standards
 - g. TIA-568-C.1-2 (November 2014) Commercial Building Telecommunications Cabling Standard, Addendum 2 General Updates
 - h. ANSI/TIA-568-C.2 (June 2016) Balanced Twisted Pair Communications Cabling and Components Standards
 - i. ANSI/TIA-568-C.3 (June 2011) Optical Fiber Cabling Components Standard
 - j. ANSI/TIA-568-C.3-1 (December 2011) Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
 - k. ANSI/TIA-1183 (August 2012) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 - I. ANSI/TIA-1183-1 (January 2016) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Addendum 1 – Extending Frequency Capabilities to 2 GHz.
 - m. ANSI/TIA-568-C.4 (July 2011) Broadband Coaxial Cabling Components Standard
 - n. ANSI/TIA-942-A (August 2012) Telecommunications Infrastructure Standard for Data Centers
 - ANSI/TIA-942-A-1 (March 2013) Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
 - p. TIA-569-D (April 2015) Telecommunications Pathways and Spaces
 - TIA-569-D-1 (October 2016) Telecommunications Pathways and Spaces Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
 - r. ANSI/TIA-606-B (December 2015) Administration Standard for Telecommunications Infrastructure
 - s. TIA-607-B (November 2015) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
 - t. TIA-607-B-1 (January 2017) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises - External Grounding Addendum
 - u. TIA-758-B (April 2012) Customer-Owned Outside Plant Telecommunication Infrastructure Standard

- v. TIA-1152 (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
- w. ANSI/TIA-862-B (February 2016) Structured Cabling Infrastructure Standard for Intelligent Building Systems.
- x. TIA-570-C (August 2012) Residential Telecommunications Infrastructure Standard
- y. TIA-1005-A (June 2012) Industrial Telecommunications Infrastructure Standard for Manufacturing, Process & Refining
- z. ANSI/TIA-1005 (January 2015) Telecommunications Infrastructure Standard for Industrial Premises
- aa. TIA-1005-1 (May 2012) Telecommunications Infrastructure Standard for Industrial Premises; Addendum 1 - Industrial Pathways and Spaces
- bb. TIA-1179 (July 2010) Healthcare Facility Telecommunications Infrastructure Standard.
- 2. ISO/IEC
 - a. ISO 11801 (November 2010) Generic Cabling for Customer Premises
 - b. ISO/IEC TR 14763-2-1:2012 Information technology -- Implementation and operation of customer premises cabling -- Part 2-1: Planning and installation - Identifiers within administration system.
- 3. National Electric Codes
 - a. National Electrical Safety Code (NESC) (IEEE C2-2012)
 - b. ANSI/NFPA 70-2014, National Electrical Code© (NEC©)
 - c. ANSI/IEEE C2-207, National Electrical Safety Code®
 - d. National Electrical Code (NEC) (NFPA 70)
- 4. OSHA Standards and Regulations all applicable
- 5. Local Codes and Standards all applicable
- 6. BICSI
 - a. Telecommunications Distribution Methods Manual, 13th Edition
 - b. BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - c. Information Technology Systems Installation Methods Manual (ITSIMM), 6th Edition
 - d. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001-2009, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. AV Design Reference Manual, 1st Edition
 - j. Network Design Reference Manual, 7th Edition
 - k. Outside Plant Design Reference Manual, 5th Edition
 - I. Wireless Design Reference Manual, 3rd Edition
 - m. Electronic Safety and Security Design Reference Manual, 3rd Edition.
- 7. Anywhere cabling Standards conflict with electrical or safety Codes, Subcontractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- 8. Knowledge and execution of applicable codes is the sole responsibility of the Sub-contractor.

9. Any code violations committed at the time of installation shall be remedied at the Sub-contractor's expense.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the architect. Any repairs or changes made necessary in the contract work, caused by the sub-contractor's neglect, shall be made by the sub-contractor at their own expense.
- B. Scheduling:
 - 1. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Manager.

1.06 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - 2. Submit product cut sheets and a detailed list of components a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The sub-contractor-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original Product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of grounding and bonding components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual, drawn component for review and action by the A/E prior to installation.
- B. Certificates:
 - 1. Submit management and installation team reference documentation verifying:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents



and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.

- b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents
- C. Qualification Statements:
 - 1. The sub-contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.
- 1.08 CLOSEOUT SUBMITTALS
 - A. As-Built Drawings:
 - 1. Submit all as-built drawings in accordance with the general requirements of the construction documents.
 - 2. Submit as-built drawings a minimum of two (2) weeks after completion of all Division- 27 work for A/E and Owner reference:
 - 3. All cabling must meet or exceed applicable TIA/EIA testing requirements and any additional parameters outlined in the Commissioning of Communications specification section 27 08 00.
 - 4. Test results must be submitted for owner review and approval adhering to the General Contractor schedule milestones related to the projects active systems integration.
- 1.09 QUALITY ASSURANCE
 - A. Qualifications Manufacturer
 - 1. Component manufactures shall be ISO 9001:2000 and offer products that are RoHS compliant.
 - B. Qualifications Installer:
 - 1. At a minimum, seventy-five percent (75%) of the onsite sub-contractor provided field technicians shall be factory certified within 12 months by the manufacturer of the selected telecommunications system components being installed. Proof of certification shall be available on site for review at all times for each field technician.
- PART 2 PRODUCTS
- 2.01 FOUR PAIR CATEGORY 6A CABLING
 - A. Basis-of-Design Product: Subject to compliance with requirements:
 - 1. Berk-Tek
 - a. LANMark-XTP Category 6A CMP Rated
 - 1) Part Number 11082057
 - B. Product Options:
 - 1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirements.
 - C. Description:

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- 1. All category-6A performance four (4) pair cable shall consist of eight (8) twentyfour (24) gauge, or greater, thermoplastic insulated solid twisted conductors that utilize the industry standard color code designations.
- 2. The performance criteria for four (4) pair cable shall be above and beyond specific EIA/TIA 568-C.2 standards for the particular cable's rating and shall show stable performance with documented electrical characterization out to 500 MHz.
- 3. Four (4) pair cables must perform over and above each of the current specification parameters for the latest published twisted pair, 10Gb performance cable solution.
- 4. Cables shall be rated per the installation environment as required by the local AHJ and local codes.
- 5. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
- 6. Cable to be run continuous without splices.
- D. Accessory Products:
 - 1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:
 - 1. Electrical requirements (conduit installation and capacity)
 - 2. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
 - 3. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.02 INSTALLATION

- A. Process:
 - 1. Install all horizontal station cabling per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA 568C and BICSI, and in quantities indicated in the drawings.
 - 2. Locations requiring horizontal cable shall be, but not limited to, CCTV, work area outlet and WiFi.
 - 3. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in BICSI guidelines. Also refer to the cable manufacturer's specifications for exact cable requirements per the particular cable type.
 - 4. All cables shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or

circumstances shall be replaced at no additional cost to the owner.

- 5. Sub-contractor shall ensure that all TIA/EIA and industry standards are met with special regards to maximum stripping length of cable jackets. No four (4) pair UTP cables shall have more than three-eight inch (3/8") of cable jacket removed beyond the termination points.
- 6. Install the horizontal cabling with attention paid to aesthetic means and methods when routing cabling within IT spaces. All horizontal cabling should terminate in their respective floor serving technology space; specifically cables from floor outlets need to terminate in their corresponding floor telecom room.
- 7. All cabling distributed horizontally through metal stud framing shall have plastic protective bushings inserted to protect cables prior to installation.
- 8. All cables shall be clearly labeled on both ends and in an accessible location no more than six inches (0'-6") from the cable ends.
- 9. The owner reserves the right to specify a new location for any outlet or equipment without increasing sub-contractor unit cost providing that the new location is specified prior to roughing-in of technology cable and is not farther than ten (10) feet away from the original location specified.

3.03 RE-INSTALLATION

- A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components. Scheduling for re- installation work shall be coordinated, in writing, with the owner prior to beginning any re- installation work
- 3.04 CLOSEOUT ACTIVITIES
 - A. Sub-contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
 - B. Sub-contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner

END OF SECTION

SECTION 27 15 43

FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Provides specifications for horizontal workstation cable termination components and outlet housing component. Includes wall-mount and ceiling-mount components to support the various workstation outlets throughout the cabling plant.
 - 2. Copper Category 6A Connectors
 - 3. Outlet Housing Components (faceplates etc.)
- 1.02 RELATED DOCUMENTS
 - A. All divisions of the specification and general provisions of the Construction Documents.
 - B. Architectural, mechanical, electrical, and all technology drawings.

1.03 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ANSI: American National Standards Institute
 - 2. A/E: Architect / Engineer (designer)
 - 3. BICSI: Building Industry Consulting Service International
 - 4. EIA: Electronics Industry Alliance
 - 5. IDF: Intermediate Distribution Facility
 - 6. LOMMF: Laser Optimized Multi-Mode Fiber
 - 7. MDF Main Distribution Facility
 - 8. NEXT: Near End Cross Talk
 - 9. PSELFEXT: Power Sum Equal Level Far End Cross Talk
 - 10. PSNEXT: Power Sum Near End Cross Talk
 - 11. RCDD: Registered Communications Distribution Designer
 - 12. SMF: Single-Mode Fiber
 - 13. TCIM: Telecommunication Cabling Installation Manual
 - 14. TDMM: Telecommunications Distribution Methods Manual
 - 15. TIA: Telecommunications Industry Association
- B. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.)
 - 1. National Electric Safety Code (2017)
 - 2. National Fire Protection Association (NFPA)
 - 3. 2016 California Electrical Code
 - 4. 2016 California Building Code
 - 5. Local Municipal Codes

1.04 APPLICABLE REGULATORY REFERENCES

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- A. Sub-contractor is responsible for knowledge and application of current versions of all applicable Standards and Codes. In cases where listed Standards and Codes have been updated, Sub-contractor shall adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.
 - 1. ANSI/TIA:
 - a. TIA-526-7 (OFSTP-7) (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. TIA-526-14-B (April 2015) (OFSTP-14) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - c. ANSI/TIA/EIA-598-C (July 2014) Optical Fiber Cable Color Coding
 - d. ANSI/TIA-568-C.0 (December 2015) Generic Telecommunications Cabling for Customer Premises
 - e. TIA-568-C.0-1 (September 2012) Generic Telecommunications Cabling for Customer Premises-Addendum 1, Updated Reference for Balanced Twisted-Pair Cabling
 - f. ANSI/TIA-568-C.1 (February 2012) Commercial Building Telecommunications Cabling Standards
 - g. TIA-568-C.1-2 (November 2014) Commercial Building Telecommunications Cabling Standard, Addendum 2 General Updates
 - h. ANSI/TIA-568-C.2 (June 2016) Balanced Twisted Pair Communications Cabling and Components Standards
 - i. ANSI/TIA-568-C.3 (June 2011) Optical Fiber Cabling Components Standard
 - j. ANSI/TIA-568-C.3-1 (December 2011) Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
 - k. ANSI/TIA-1183 (August 2012) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 - I. ANSI/TIA-1183-1 (January 2016) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Addendum 1 – Extending Frequency Capabilities to 2 GHz.
 - m. ANSI/TIA-568-C.4 (July 2011) Broadband Coaxial Cabling Components Standard
 - n. ANSI/TIA-942-A (August 2012) Telecommunications Infrastructure Standard for Data Centers
 - ANSI/TIA-942-A-1 (March 2013) Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
 - p. TIA-569-D (April 2015) Telecommunications Pathways and Spaces
 - TIA-569-D-1 (October 2016) Telecommunications Pathways and Spaces Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
 - r. ANSI/TIA-606-B (December 2015) Administration Standard for Telecommunications Infrastructure
 - s. TIA-607-B (November 2015) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
 - t. TIA-607-B-1 (January 2017) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises - External Grounding Addendum
 - u. TIA-758-B (April 2012) Customer-Owned Outside Plant Telecommunication Infrastructure Standard

- v. TIA-1152 (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
- w. ANSI/TIA-862-B (February 2016) Structured Cabling Infrastructure Standard for Intelligent Building Systems.
- x. TIA-570-C (August 2012) Residential Telecommunications Infrastructure Standard
- y. TIA-1005-A (June 2012) Industrial Telecommunications Infrastructure Standard for Manufacturing, Process & Refining
- z. ANSI/TIA-1005 (January 2015) Telecommunications Infrastructure Standard for Industrial Premises
- aa. TIA-1005-1 (May 2012) Telecommunications Infrastructure Standard for Industrial Premises; Addendum 1 - Industrial Pathways and Spaces
- bb. TIA-1179 (July 2010) Healthcare Facility Telecommunications Infrastructure Standard.
- 2. ISO/IEC
 - a. ISO 11801 (November 2010) Generic Cabling for Customer Premises
 - b. ISO/IEC TR 14763-2-1:2012 Information technology -- Implementation and operation of customer premises cabling -- Part 2-1: Planning and installation - Identifiers within administration system.
- 3. National Electric Codes
 - a. National Electrical Code (2017)
 - b. ANSI/NFPA 70-2017, National Electrical Code© (NEC©)
 - c. ANSI/IEEE C2-207, National Electrical Safety Code®
 - d. National Electrical Code (NEC) (NFPA 70)
- 4. OSHA Standards and Regulations all applicable
- 5. Local Codes and Standards all applicable
- 6. BICSI
 - a. Telecommunications Distribution Methods Manual, 13th Edition
 - b. BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - c. Information Technology Systems Installation Methods Manual (ITSIMM), 6th Edition
 - d. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001-2009, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. AV Design Reference Manual, 1st Edition
 - j. Network Design Reference Manual, 7th Edition
 - k. Outside Plant Design Reference Manual, 5th Edition
 - I. Wireless Design Reference Manual, 3rd Edition
 - m. Electronic Safety and Security Design Reference Manual, 3rd Edition.
- 7. Anywhere cabling Standards conflict with electrical or safety Codes, Contractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- 8. Knowledge and execution of applicable codes is the sole responsibility of the Sub-contractor.

9. Any code violations committed at the time of installation shall be remedied at the Sub-contractor's expense.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the architect. Any repairs or changes made necessary in the contract work, caused by the sub-contractor's neglect, shall be made by the sub-contractor at their own expense.
- B. Scheduling:
 - 1. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Manager.

1.06 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - 2. Submit product cut sheets and a detailed list of components a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The sub-contractor-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original Product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of two (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of grounding and bonding components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual, drawn component for review and action by the A/E prior to installation.
- B. Certificates:
 - 1. Submit management and installation team reference documentation verifying:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents



and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.

- b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents
- C. Qualification Statements:
 - 1. The sub-contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.
- 1.08 CLOSEOUT SUBMITTALS
 - A. As-Built Drawings:
 - 1. Submit all as-built drawings in accordance with the general requirements of the construction documents.
 - 2. Submit as-built drawings a minimum of two (2) weeks after completion of all Division- 27 work for A/E and Owner reference:
- 1.09 QUALITY ASSURANCE
 - A. Qualifications Manufacturer
 - 1. Component manufactures shall be ISO 9001:2000 and offer products that are RoHS compliant.
 - B. Qualifications Installer:
 - 1. At a minimum, seventy-five percent (75%) of the onsite sub-contractor provided field technicians shall be factory certified within 12 months by the manufacturer of the selected telecommunications system components being installed. Proof of certification shall be available on site for review at all times for each field technician.
- PART 2 PRODUCTS
- 2.01 COPPER UTP CONNECTORS
 - A. Basis-of-Design Product: Subject to compliance with requirements:
 - 1. Leviton: Category UTP Category 6A Connectors.
 - B. Product Options:
 - 1. The manufacturers noted above shall be the only manufacturers acceptable to the Owner and A/E.
 - C. Description:
 - 1. All UTP connectors shall be rated to perform at or above current TIA/EIA performance parameters of the UTP cabling it is terminating within the communications system.
 - 2. All UTP connectors shall have an eight (8) position, eight (8)-conductor module that accepts RJ-45 plugs.
 - 3. When utilized as part of a channel or permanent link, all high performance modular outlet connectors shall not decrease the horizontal cable elevated performance transmission requirements before and after installation as specified



in ANSI/TIA/EIA 568-C Commercial Building Telecommunications Cabling Standard (horizontal cable section) in all noted performance parameters.

- D. Accessory Products:
 - 1. Provide any accessory products related to the UTP connectors required to provide a complete and functional infrastructure system.
 - 2. Port RJ-45 jack block out device to safely secure access to unused ports and deter vandalism to jacks.
 - 3. Provide complete with all required mounting hardware and fittings and cables needed.

2.02 OUTLET HOUSING COMPONENTS

- A. Manufacturer List:
 - 1. Leviton

b.

- a. Cat6A Connectors Atlas-X1
 - 1) Part Number 6AUJK-RL6 (L=Blue)
 - Wall Plates 4-Port Angled Single Gang
 - 1) Part Number 42081-4Xs (x-Color)
- B. Product Options:
 - 1. The manufacturers noted above shall be the only manufacturers acceptable to the Owner and A/E.
- C. Description:
 - 1. All outlet housings at the various technology outlet locations shall provide the designated number modular insert ports as indicated in the drawings.
 - 2. All flush-mounted faceplates shall be provided per the port configurations shown on the telecom drawings.
 - 3. System furniture faceplates shall be capable of fitting in the furniture system selected by the Owner. Furniture faceplates shall be provided per the port configurations shown on the telecom drawings. Furniture faceplate extenders shall be used (if required) to maintain proper bend radii within the furniture raceway/pathway.
 - 4. Surface mounted boxes shall be capable of the quantity of outlet jack requirements at each outlet locations indicted in the drawings.
 - 5. All outlet-housings shall provide a clear TIA/EIA 606-A labeling location for both the individual outlet port and the entire outlet housing location, unless otherwise indicated in the project drawings.
- D. Accessory Products:
 - 1. Provide any accessory products related to the workstation outlet housing components required to provide a complete and functional infrastructure system.

PART 3 - EXECUTIONEXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:
 - 1. Electrical requirements (conduit installation and capacity)

- 2. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
- 3. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.02 INSTALLATION

- A. Process:
 - 1. Install all connectors and couplers under the guidelines of the manufacturers' recommended instructions and per all TIA/EIA 568C standards, BICSI guidelines, and manufacturer approved industry practices.
 - 2. The installation and performance parameters of all installed couplers and connectors shall be verified by the trade sub-contractor through TIA/EIA 568C testing procedures.
 - 3. Color of all outlet housing components shall be coordinated with the Owner before purchase and installation.
 - 4. All technology outlets located on walls shall be flush mounted, level and plumb.
 - 5. All technology outlets shall be mounted at right angles and parallel to the floor, unless installation requirements or design dictate otherwise.
 - 6. Install blank inserts in outlet housing spaces that are not being filled with cable termination modules. Blank inserts shall match the workstation housing color, unless otherwise indicated in the drawings.
 - 7. All outlets located in systems furniture may be served from a wall adjacent to the furniture cluster or a floor box. If the cable is exposed prior to entering furniture raceway, install spiral wrap tubing to protect the cable per the manufacturer's recommendations.
 - 8. All outlet housings as well as each individual utilized port must be labeled in accordance with the Owner-approved labeling scheme.

3.03 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components. Scheduling for re- installation work shall be coordinated, in writing, with the owner prior to beginning any re- installation work

3.04 CLOSEOUT ACTIVITIES

- A. Sub-contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
- B. Sub-contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner

END OF SECTION

SECTION 27 16 19

COMMUNICATION PATCH CORDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Provides specifications for Category 6A horizontal cable patching to distribute network signals.
 - 2. Copper Category 6A Patch Cords.
- 1.02 RELATED DOCUMENTS
 - A. All divisions of the specification and general provisions of the Construction Documents.
 - B. Architectural, mechanical, electrical, and all technology drawings.
- 1.03 REFERENCES
 - A. Abbreviations and Acronyms:
 - 1. ANSI: American National Standards Institute
 - 2. A/E: Architect / Engineer (designer)
 - 3. BICSI: Building Industry Consulting Service International
 - 4. EIA: Electronics Industry Alliance
 - 5. IDF: Intermediate Distribution Facility
 - 6. LOMMF: Laser Optimized Multi-Mode Fiber
 - 7. MDF Main Distribution Facility
 - 8. NEXT: Near End Cross Talk
 - 9. RCDD: Registered Communications Distribution Designer
 - 10. SMF: Single-Mode Fiber
 - 11. TCIM: Telecommunication Cabling Installation Manual
 - 12. TDMM: Telecommunications Distribution Methods Manual
 - 13. TIA: Telecommunications Industry Association
 - B. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.)
 - 1. National Electric Safety Code (NESC) 2017
 - 2. National Fire Protection Association (NFPA)
 - 3. 2016 California Electrical Code
 - 4. 2016 California Building Code
 - 5. Local Municipal Codes

1.04 APPLICABLE REGULATORY REFERENCES

A. Sub-contractor is responsible for knowledge and application of current versions of all applicable Standards and Codes. In cases where listed Standards and Codes have been updated, Sub-contractor shall adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.

- 1. ANSI/TIA:
 - a. TIA-526-7 (OFSTP-7) (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. TIA-526-14-B (April 2015) (OFSTP-14) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - c. ANSI/TIA/EIA-598-C (July 2014) Optical Fiber Cable Color Coding
 - d. ANSI/TIA-568-C.0 (December 2015) Generic Telecommunications Cabling for Customer Premises
 - e. TIA-568-C.0-1 (September 2012) Generic Telecommunications Cabling for Customer Premises-Addendum 1, Updated Reference for Balanced Twisted-Pair Cabling
 - f. ANSI/TIA-568-C.1 (February 2012) Commercial Building Telecommunications Cabling Standards
 - g. TIA-568-C.1-2 (November 2014) Commercial Building Telecommunications Cabling Standard, Addendum 2 General Updates
 - h. ANSI/TIA-568-C.2 (June 2016) Balanced Twisted Pair Communications Cabling and Components Standards
 - i. ANSI/TIA-568-C.3 (June 2011) Optical Fiber Cabling Components Standard
 - j. ANSI/TIA-568-C.3-1 (December 2011) Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
 - k. ANSI/TIA-1183 (August 2012) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 - I. ANSI/TIA-1183-1 (January 2016) Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Addendum 1 – Extending Frequency Capabilities to 2 GHz.
 - m. ANSI/TIA-568-C.4 (July 2011) Broadband Coaxial Cabling Components Standard
 - n. ANSI/TIA-942-A (August 2012) Telecommunications Infrastructure Standard for Data Centers
 - ANSI/TIA-942-A-1 (March 2013) Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
 - p. TIA-569-D (April 2015) Telecommunications Pathways and Spaces
 - TIA-569-D-1 (October 2016) Telecommunications Pathways and Spaces Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
 - r. ANSI/TIA-606-B (December 2015) Administration Standard for Telecommunications Infrastructure
 - s. TIA-607-B (November 2015) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
 - t. TIA-607-B-1 (January 2017) Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises - External Grounding Addendum
 - u. TIA-758-B (April 2012) Customer-Owned Outside Plant Telecommunication Infrastructure Standard
 - v. TIA-1152 (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - w. ANSI/TIA-862-B (February 2016) Structured Cabling Infrastructure Standard for Intelligent Building Systems.

- x. TIA-570-C (August 2012) Residential Telecommunications Infrastructure Standard
- y. TIA-1005-A (June 2012) Industrial Telecommunications Infrastructure Standard for Manufacturing, Process & Refining
- z. ANSI/TIA-1005 (January 2015) Telecommunications Infrastructure Standard for Industrial Premises
- aa. TIA-1005-1 (May 2012) Telecommunications Infrastructure Standard for Industrial Premises; Addendum 1 - Industrial Pathways and Spaces
- bb. TIA-1179 (July 2010) Healthcare Facility Telecommunications Infrastructure Standard.
- 2. ISO/IEC
 - a. ISO 11801 (November 2010) Generic Cabling for Customer Premises
 - b. ISO/IEC TR 14763-2-1:2012 Information technology -- Implementation and operation of customer premises cabling -- Part 2-1: Planning and installation - Identifiers within administration system.
- 3. National Electric Codes
 - a. National Electrical Safety Code (2017)
 - b. ANSI/NFPA 70-2017, National Electrical Code© (NEC©)
 - c. ANSI/IEEE C2-207, National Electrical Safety Code®
 - d. National Electrical Code (NEC) (NFPA 70)
- 4. OSHA Standards and Regulations all applicable
- 5. Local Codes and Standards all applicable
- 6. BICSI
 - a. Telecommunications Distribution Methods Manual, 13th Edition
 - b. BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - c. Information Technology Systems Installation Methods Manual (ITSIMM), 6th Edition
 - d. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001-2009, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. AV Design Reference Manual, 1st Edition
 - j. Network Design Reference Manual, 7th Edition
 - k. Outside Plant Design Reference Manual, 5th Edition
 - I. Wireless Design Reference Manual, 3rd Edition
 - m. Electronic Safety and Security Design Reference Manual, 3rd Edition.
- 7. Anywhere cabling Standards conflict with electrical or safety Codes, Subcontractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- 8. Knowledge and execution of applicable codes is the sole responsibility of the Sub-contractor.
- 9. Any code violations committed at the time of installation shall be remedied at the Sub-contractor's expense.

1.05 ADMINISTRATIVE REQUIREMENTS5015021-100Palomar College Escondido - HVAC Lab10.04.2016

COMMUNICATION PATCH CORDS 27 16 19 - 3

- A. Coordination:
 - 1. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the architect. Any repairs or changes made necessary in the contract work, caused by the sub-contractor's neglect, shall be made by the sub-contractor at their own expense.
- B. Scheduling:
 - 1. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Manager.

1.06 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - 2. Submit product cut sheets and a detailed list of components a minimum of six (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The sub-contractor-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original Product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.
- B. Samples:

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of six (2) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of grounding and bonding components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual, drawn component for review and action by the A/E prior to installation.
- B. Certificates:
 - 1. Submit management and installation team reference documentation verifying:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.

- b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents
- C. Qualification Statements:
 - 1. The sub-contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.

1.08 CLOSEOUT SUBMITTALS

- A. As-Built Drawings:
 - 1. Submit all as-built drawings in accordance with the general requirements of the construction documents.
 - 2. Submit as-built drawings a minimum of two (2) weeks after completion of all Division- 27 work for A/E and Owner reference:
- 1.09 QUALITY ASSURANCE
 - A. Qualifications Manufacturer
 - 1. Component manufactures shall be ISO 9001:2000 and offer products that are RoHS compliant.
 - B. Qualifications Installer:
 - 1. At a minimum, seventy-five percent (75%) of the onsite sub-contractor provided field technicians shall be factory certified within 12 months by the manufacturer of the selected telecommunications system components being installed. Proof of certification shall be available on site for review at all times for each field technician.
- PART 2 PRODUCTS

2.01 COPPER UTP PATCH CORDS

- A. Basis-of-Design Product: Subject to compliance with requirements:
 - 1. Leviton:
 - a. TR Patch Cords Atlas-X1 Cat6A Slimline Black
 - 1) Part Number 6AS10-05E (5') (E=Black)
 - 2) Part Number 6AS10-07E (7') (E=Black)
 - b. Station Patch Cords Atlas-X1 Cat6A Slimline Blue
 - 1) Part Number 6AS10-xxL (xx=3,5,7,10,15,20 Feet) (L=Black)
- B. Product Options:
 - 1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.
- C. Description:
 - 1. Category UTP Copper patch cords for equipment patching (RJ-45 to RJ-45 Cords): Modular RJ45 male plug connector's equipped with (8) eight gold anodized pins shall be factory terminated at each end of the patch cords. Modular plug connectors will be snag free in design or will utilize a molded plastic boot to cover the modular plug tab. Category 6A UTP cords shall be 26 AWG.

- 2. All patch cords shall conform to the requirements of the EIA/TIA 568C.2 standard performance parameters and shall also guarantee headroom margin above the minimum EIA/TIA 568C standard NEXT and PSNEXT requirements; and shall provide positive ACR to 5000 MHz-km as part of the connectivity system.
- 3. All copper UTP patch cords shall have stranded conductors that match the EIA/TIA 568-C performance characteristics of the category cable specified.
- 4. Patch cord performance levels shall be equal to or greater than the performance level of the installed UTP cabling system.
- 5. All copper patch cord lengths for patching inside the telecom rooms are to be provided appropriate to patching from network equipment ports to the copper patch panels ports within the IDF.
- D. Accessory Products:
 - 1. Provide any accessory products related to the UTP connectors required to provide a complete and functional infrastructure system.
 - 2. Port RJ-45 patch cord lock-in device to safely secure access to patched cords and deter accidental removal to network connection.
 - 3. Provide complete with all required mounting hardware and fittings and cables needed.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:
 - 1. Electrical requirements (conduit installation and capacity)
 - 2. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
 - 3. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.02 INSTALLATION

- A. Process:
 - 1. Install all horizontal cable per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA 568 C and BICSI.
 - 2. Category 6A equipment Patch cords: Provide (2) copper patch cords (one for each end of the cable termination) for every Category cable installed.
 - 3. All patch cord lengths are to be provided appropriate to patch from rack mounted network equipment ports to the rack mounted horizontal station outlet patch panel ports within the IDF and from the workstation outlet to the computer/or other IP end device NIC card/RJ45 port.
 - 4. Provide new, sealed patch cords in lengths, colors and counts approved in writing by the owner.
 - 5. It will be the responsibility of the communication sub-contractor to provide install all Category 6A patch cords per direction and coordination of owner IT dept.

3.03 RE-INSTALLATION

A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components. Scheduling for re- installation work shall be coordinated, in writing, with the owner prior to beginning any re- installation work.

3.04 CLOSEOUT ACTIVITIES

- A. Sub-contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
- B. Sub-contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION

SECTION 27 51 26

ASSISTIVE LISTENING SYSTEM (ALS)

PART 1 GENERAL

1.1 SUMMARY

- A. The work includes the provision of Assistive Listening Systems (ALS) as part of the building project.
- B. In the absence of fixed ALS, portable ALS shall be provided and installed by the Campus, where specified.
- C. Scope of Work: The work shall consist of the design, provision, termination, testing, and documentation of a complete and fully functional ALS. The instructions in this section are specific to the ALS installations and should be read in conjunction with other contract documents as applicable.

PART 2 PRODUCTS

2.1 ASSISTIVE LISTENING SYSTEM

- A. Furnish an FM wireless assistive listening system for use by the hearing-impaired. There will an installed portable RF system to utilize in the smaller systems. The assistive listening system (ALS) shall be capable of broadcasting on 57 channels and be frequency agile. The ALS system shall have 80dB SNR or greater, end-to-end. Receivers shall be frequency agile and frequency set with a "seek" button. The receiver will incorporate a stereo headset jack that allows the user to plug in either a mono or stereo headset and listen to audio normally. The portable receivers and transmitters shall incorporate automatic battery charging circuitry for recharging of Ni-MH batteries. Listen Technologies Corporation products are specified. Provide Portable ALS systems per specifications.
- B. Portable RF ALS System Furnish and install the following:
 - 1. Listen Technologies LT-700-072 Portable Transmitter (Qty: 1 ea.)
 - 2. Listen Technologies LA-278 Behind-the-Head Microphone (Qty: 1 ea.)
 - 3. Listen Technologies LR-400-072 Portable Display receiver (Qty: 6 ea.)
 - 4. Listen Technologies LA-164 Ear Speaker (Qty: 6 ea.)
 - 5. Listen Technologies LA-166 Neck Loop. (Qty: 6 ea.)
 - 6. Listen Technologies LA-362 NiMH rechargeable batteries. (Qty: 7 ea.)
 - 7. Listen Technologies LA-321-01 8-Unit Charging/Carrying Case (Qty 1 ea.)

8. Listen Technologies LA-304 ADA Access/Compliance signage kit. (Qty 1 each per room.)

PART 3 EXECUTION

- 3.1 EQUIPMENT INSTALLATION
 - A. Assistive Listening transmitters shall be provided by the Campus in the following rooms:
 - 1. Provide portable transmitters per AV Specifications and Major Equipment and Approved Manufacturer List for each phase.
 - 2. Each room with a sound reinforcement system and 50 seats or more shall receive a fixed and installed ALS transmitter system.
 - 3. If multiple transmitters are specified within a facility, it is recommended that the adjacent transmitter channels be at least 300 MHz apart. If no interference, the following channels are recommended; A, C, E, I, J and H.
 - B. Assistive Listening receivers shall be provided by the Owner as follows:
 - 1. Provide headset receivers shall have receivers available for checkout per the campus assigned personnel.
 - 2. Each portable system will be provided with 6 receivers
 - C. Portable ALS transmitters and receivers will be given by the owner for distribution.
 - D. Equipment to be installed in accordance with manufacturer's instructions.
- 3.2 TESTING
 - A. Following the installation of transmitters and antenna, each transmitter and receiver will be tested.
 - B. Transmitters shall support signal distribution at all specified channels at any position in the instructional room to which its use is dedicated.
 - C. Receivers shall be tested to verify function as specified by manufacturer.

END OF SECTION



SECTION 28 01 00

ELECTRONIC SAFETY AND SECURITY GENERAL PROVISIONS

ARTICLE 1 - SUMMARY

- 1.1 This Division of the specifications outlines the provisions of the contract work to be performed as a sub contract under the Division 26 scope of work. Reference the Division 26 Electrical General Provisions for scope of work and general requirements.
- 1.2 In addition, work in this Division is governed by the provisions of the bidding requirements, contract forms, general conditions and all sections under Division 1 requirements.

END OF SECTION

SECTION 28 30 00

FIRE ALARM SYSTEM

PART 1 – GENERAL

1.1 Work Included:

1.1.1 Furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating fire alarm system.

1.2 Related Work:

- 1.2.1 Division 26 01 00: Electrical General Provisions
- 1.2.2 Division 26 05 33: Conduit and Fittings
- 1.2.3 Division 26 05 34: Outlet and Junction Boxes
- 1.3 The equipment and installation shall comply with the current applicable provisions of the following standards:

NFPA 72-2016	. National Fire Alarm Code with California Amendments.
CBC - 2016	. California Building Code (CBC), Part 2, Title 24, CCR.
CEC - 2016	. California Electrical Code, (CEC), Part 3, Title 24, CCR.
CFC - 2016	California Fire Code (CFC), Part 9, Title 24, CCR.

1.4 The system and all components shall be listed by Underwriters Laboratories, Inc. for use in Fire Protective Signaling Systems under the following standards as applicable:

UL 38	.Manually Actuated Signaling Boxes.
UL 50	.Cabinets and Boxes.
UL 268	.Smoke Detectors for Fire Protective Signaling Systems.
UL 268A	.Smoke Detectors for Duct Applications
UL 346	.Waterflow Indicators for Fire Protective Signaling
	Systems.
UL 464	Audible Signaling Appliances.
UL 521	Heat Detectors for Fire Protective Signaling Systems.
UL 864	.Control Units for Fire Protective Signaling Systems.
UL 1481	Power supplies for Fire Protective Signaling Systems.
UL 1971	. Visual Signaling Appliances.

- 1.5 Only Fire Alarm Control Panel Equipment and Peripheral Field Devices have been shown on the Contract Bid Single Line Block Diagram. Specific and complete wiring between Control Equipment and Peripheral Equipment has been deleted for clarity.
- 1.6 Submittal shall be made <u>in accordance with Division 26 01 00 Shop</u> <u>Drawings and Submittals.</u> This submittal shall include the following:

- 1.6.1 Complete bills of quantities, including all materials, components, devices, and equipment required for this work. The bills of quantities shall be tabulated respective of each and every system as specified, and shall contain the following information for each item listed:
 - 1.6.1.1 Quantity of each type of equipment item.
 - 1.6.1.2 Description of each item.
 - 1.6.1.3 Manufacturer's Name and Model Number.
 - 1.6.1.4 Manufacturer's Specification Sheet.
 - 1.6.1.5 California State Fire Marshall Listing Sheets for all components.
 - 1.6.1.6 Equipment items which have individual components, will require that all component parts be listed individually.
 - 1.6.1.7 Letter indicating the contractor's intent to comply with Phase II submittal drawings.
- 1.7 Phase II Submittal shall be provided <u>within (20) working days</u> after the approval of the Phase I submittals and prior to any fabrication or field conduit installations. All shop drawings shall be engineered and drawn on a CAD System. Each submission shall include 'D' or 'E' size print copies to match the contract drawings, and one (1) data disk copy with files in a AutoCAD 2000i or 2004 format . Building floor plan CAD files on disk, will be made available via express mail <u>after the receipt of payment</u> of \$50.00 per building floor plan, or \$300.00 minimum which ever is <u>less</u>. Contractor shall make the request for drawings in writing directly to Johnson Consulting Engineers, confirmation of the request and a release form will be forwarded to the contractor to include a signed copy with payment prior to release of files. Detail or riser diagram sheets or any other drawings other than floor or site plans, will not be made available to the contractor.

1.7.1 **Provide complete shop drawings to include the following:**

- 1.7.1.1 Complete floor plans, at scale of contract documents, showing the locations throughout the project of all receptacles, conduits, wireways, tray, pullboxes, junction boxes, equipment racks, and other devices.
- 1.7.1.2 Point to point wiring diagrams showing wiring from panel terminals to each device.
- 1.7.1.3 Scaled floor plans indicating the location of devices, conduit runs, types, and number of conductors.
- 1.7.1.4 Riser diagram indicating all wiring and circuits.
- 1.7.1.5 Current State Fire Marshal listing sheets for all components and devices.

- 1.7.1.6 Provide battery power supply calculations, indicate point of power supply connection, means of disconnect, over-current protection, etc. for each panel.
- 1.7.1.7 Provide detailed information on conductors to be usedmanufacturer, type, size, insulation, etc.
- 1.7.1.8 Provide voltage drop calculations for all conductor run is from each panel (i.e., main FACP, remotes, power extenders, etc.) for each panel.
- 1.7.1.9 Provide written sequence of system operation matrix.
- 1.7.1.10 Provide list of zones. (Every device that is addressable.)
- 1.7.1.11 Provide detailed drawing for annunciator panel indicating all zones and initiating devices.

1.8 **Common submittal mistakes which will result in submittals being rejected:**

- 1.8.1 Not including the qualifications of the installing contractor.
- 1.8.2 Not including all items listed in the above itemized description.
- 1.8.3 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed, or crossing out the items which are not applicable.
- 1.8.4 Not including actual manufacturer's catalog information of proposed products.
- 1.8.5 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements, or "to be determined later" statements. The products being submitted must be the products installed.
- 1.9 All equipment and material shall be new and unused, and listed by Underwriter's Laboratories for the specific intended purpose. All control panel components and field peripherals shall be designed for continuous duty without degradation of function or performance. All equipment covered by this specification or noted on Installation. Drawings shall be equipment suited for the application and shall be provided by a single manufacturer or be recognized and UL listed as compatible by both manufacturers.
- 1.10 It will be the responsibility of the Contractor to ensure proper specification adherence for system operation, final connection, test, turnover, warranty compliance, and after-market service. The distributor of the equipment specified must be factory-trained and certified.

- 1.11 Basic System Functional Operation, upon operation of any automatic, manual or other initiation device the following shall occur:
 - 1.11.1 The system alarm LED shall flash.
 - 1.11.2 A local piezo electric signal in the control panel shall sound.
 - 1.11.3 A backlit 80-character LCD display shall indicate all information associated with the fire alarm condition, including the alarm point and its location within the protected premises.
 - 1.11.4 History storage equipment shall log the information associated with each new fire alarm control panel condition, along with time and date of occurrence.
 - 1.11.5 All system output programs assigned via control by event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
 - 1.11.6 LED display and audible signaling at the remote annunciator indicating building, fire zone, and type of device. Annunciator shall also provide a separate audible signal for CO detection with a green flashing light, with classroom number indication.
 - 1.11.7 Automatic retransmission to a UL central station for fire department notification.
 - 1.11.8 Automatic shut down of air conditioning units and/or smoke dampers furnished with duct detectors. Each building shall shut down all A/C units and dampers within that building as one zone.
- 1.12 All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approval agency for use as part of a protective signaling system, meeting the NFPA 72, 2016 Edition with California State Amendments.
- 1.13 All equipment and components shall be installed in strict compliance with manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.
- 1.14 All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. Fasteners and supports shall be adequate to support the required load.
- 1.15 All wiring shall be installed in a conduit system.

- 1.16 The contractor shall provide as a part of this contract additional control modules, heat detectors, smoke detectors, CO detector, duct detectors, manual pull stations, strobes, mini-horns and exterior horn devices etc., to equal 10% of the total quantity of devices shown on the drawings, or a minimum of three (3) for each type, whichever is greater. Installation of conduit, boxes and wiring of these devices shall be included, and required locations coordinated with CSFM final approved shop drawings. Any devices not required to be included during construction shall be delivered to the District at the completion of the project. The quantities of these devices shall be listed as a part of the Phase I submittals.
- 1.17 The installing contractor shall provide a copy of current documentation, indicating that the contractor installing the fire alarm systems or devices and wiring, is certified by Underwriters Laboratories (UL) in its product directories under the listing category "PROTECTIVE SIGNALING SERVICES LOCAL, AUXILIARY, REMOTE STATION, AND PROPRIETARY." The contractor shall be certified by the manufacturer to install and program the system. The contractor must also provide complete installation of all wiring and equipment, and software programming. Supervised installation of the wiring, devices and/or any software programming shall not be permitted.
 - 1.17.1 The installing contractor must also be an "authorized dealer" by the equipment manufacturer and must have completed all required training prior to the bid of this project.
 - 1.17.2 The fire alarm system installation shall be warranted by the manufacturer's representative.
 - 1.17.3 The Contractor shall have a current California C-10 or C-7 Contractor's License, and all individuals working on this project shall have passed the Department of Industrial Relations Division of Apprenticeship Standards "Fire / Life Safety Certification Program."
 - 1.17.4 The installing contractor shall provide, at the time of submittal, a letter of intent to provide an extended service warranty. This warranty shall extend for a total of three (3) years, starting at the completion, testing, and training of this project. The service warranty shall cover all material and labor to keep operational all system devices installed under this project, and shall include two (2) complete U.L. system's tests and cleaning of all devices at year two (2) and year three (3) of the warranty. Routine cleaning of devices, other than at the two (2) specified U.L. system's testing periods, will not be included as a part of this warranty.
 - 1.17.5 The installing contractor shall provide, at the time of submittal, a letter indicating that the installation crew for this project meets the following NICET certifications:
 - 1.17.5.1 25% of the installing field personnel must have completed NICET Level 2 Certification.

- 1.17.5.2 One of the installing field personnel and /or supervisor must have completed NICET Level 3 Certification.
- 1.17.5.3 Contractor shop drawings shall be signed by an individual who has completed NICET Level 4 Certification.
- 1.18 All conduit and standard backboxes will be furnished and installed by the Division 26 Contractor. Specialty boxes will be furnished by the equipment supplier to be installed by the Division 26 Contractor.
- 1.19 Equipment and materials shall be the standard product of Simplex.

Alternate equipment as manufactured by any other manufacturer not specifically listed above will not be approved for use on this project. D.S.A approved drawings are included as a part of the drawing set

PART 2 - PRODUCTS

- 2.1 Main Fire Alarm Control Panel
 - 2.1.1 Fire alarm control panel is existing Simplex #4100U Series.
 - 2.1.2 The system shall be controlled and supervised by a microprocessor based monitoring fire alarm control panel. The systems shall be addressable, field configurable, programmable and editable. The system shall continuously scan devices for change of status. Each device shall have its own unique address but shall also be grouped by building as a separate zone for remote annunciation and alarm report purposes.
 - 2.1.3 The system shall be provided with a networking card and software and modem to communicate with the District-wide diagnostic and annunciation network.
 - 2.1.4 The fire alarm control panel shall be housed in a lockable, code gauge steel cabinet with 80-character LCD display, master controller operators panel, Indicating lamps, silence switch and reset switch mounted on cabinet front. The fire alarm control panel shall be physically and visually located in the general office for monitoring by staff and shall sound the "Temporal Pattern" in all zones. Signal duration shall be field programmable and initially set at three minutes. Provide all control modules, synchronous modules, etc., to provide a complete working system per all codes that apply.
 - 2.1.5 The fire alarm control panel shall come with standardized software for onsite customization of the system. The unit shall be capable of providing a 600-event historical log with zone or point selectable alarm verification.
 - 2.1.6 The unit shall support 127 addressable points per module and one output point, SPST contact per zone. Provide the number of modules



necessary to control and supervise fire alarm devices as shown on the Drawings, as well as to provide 25% spare capacity.

- 2.1.7 The fire alarm control panel shall be capable of providing a walk test.
- 2.2 The power feed for the FACP shall be 3-wire, 120volt, AC, single phase (20A circuit) permanently labeled "FIRE ALARM CONTROL POWER", terminating at the master fire alarm control and supervisory panel. The label shall be red with 1/4" high white lettering. The source circuit breaker must be provided with a lock-on device.
- 2.3 In addition to the AC circuit, the panel shall be equipped with a DC battery to activate an audible alarm and pilot light in case of a power failure on the AC circuit.
- 2.4 Batteries must drive signaling devices per current requirements of California State Fire Marshal. Battery calculations are required as part of the submittal.
- 2.5 The master fire alarm panel shall be equipped with a manual pull lever type, supervised report station.
- 2.6 With the exception of the manually operated report station required at the master fire alarm panel and large assembly areas, the remainder of the school facility shall be equipped with approved, electronically supervised, automatic fire detection devices, such that every room, space, including concealed spaces, such as the attic spaces above ceilings, etc., is provided with approved coverage.
- 2.7 Automatic fire detection devices shall be addressable analog smoke and heat detectors. Where used, heat detectors shall be fixed temperature x-rate of rise, fixed at 135EF and a 15EF/min rate of rise. In janitor rooms equipped with kilns, devices shall be fixed at 170EF.
- 2.8 MANUAL FIRE ALARM STATIONS shall be addressable test-reset lock in order that they may be tested, and so designed that after actual emergency operation, they cannot be restored to normal, except by use of a key. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 100 feet, front or side. Manual stations shall be constructed of die-formed, satin-finished aluminum, with operating directions provided on the cover in depressed red letters. The word FIRE shall appear on each side of the stations in depressed letters, 1/2-inch in size or larger. Stations shall be suitable for semi-flush mounting on a standard single-gang box or switch plate, and shall be provided with a terminal block for connection of fire alarm system wiring. Manual pull stations must comply with CBC sections 11B-309 and 11B-403.
- 2.9 HORN / STROBE DEVICE shall be of the semi-flush type designed for mounting to a standard four-inch square electrical outlet box. Each device shall be provided with a semi-flush accessory plate. Exterior horns shall be weatherproof. The strobe unit shall have a meantime between failure (MTBF) of 1,000 hours or greater. The strobe section shall have a minimum flash rate of approximately
one flash per second, with candela rating as per UL standard 1971. Housing shall be white.

- 2.9.1 In areas containing two or more audible devices, or three or more visual devices, these devices shall be synchronized, Per NFPA 72, Chapter 6 California Amendments (2016).
- 2.10 STROBES. The strobe unit shall have a meantime between failure (MTBF) of 1,000 hours or greater. The strobe section shall have a minimum flash rate of approximately one flash per second, with candela rating as per UL standard 1971. Housing shall be white.
 - 2.10.1 In areas containing two or more audible devices, or three or more visual devices, these devices shall be synchronized, per NFPA 72, Chapter 6 California Amendments (2016).
 - 2.10.2 Maximum pulse duration to be 0.20 of a second with an ADAAG 4.28.3(3). Visual alarms maximum duty cycle of 40%.
 - 2.10.3 Capable of providing minimum candela. Intensity as shown on plans (effective strength measured at the source).
 - 2.10.4 The flash rate to be a minimum of 1.Hz and a maximum of 3 Hz.
- 2.11 HEAT DETECTOR DEVICES shall be addressable, fixed temperature x rate of rise, fixed at 135EF and a 15EF/min rate of rise. In janitor rooms equipped with kilns, devices shall be fixed at 170EF.
- 2.12 SMOKE DETECTOR DEVICES shall be analog addressable, photo-electric.
- 2.13 CO CARBON MONOXIDE detectors shall be provided in all Group E Classrooms and provided with a sounder base to alarm individual classrooms with a 4-pulse temporal pattern as well as transmitting to the staffed remote annunciator.
- 2.14 DUCT TYPE DETECTORS shall be analog addressable, photo-electric type, provide with remote test switch and auxiliary contacts as required for control of A/C units or smoke dampers.
- 2.15 DIGITAL ALARM COMMUNICATOR TRANSMITTER. The control panel shall have the ability to meet the requirements of UL 864 for central station connections, and shall be UL listed for use with the fire alarm control panel. The communicator shall be connected to supervise two telephone lines, all wiring required for this connection shall be provided by the fire alarm contractor Coordinate interface with District monitoring company as required.
- 2.16 REMOTE ANNUNCIATOR shall be an 80 character backlit, alphanumeric, LCD readout display. The display shall include alarm, supervisory, CO detection and trouble condition LEDs and tone alert. Each condition shall have a dedicated



acknowledge push button switch to silence the local tone alert but leaves the LED lights on until all conditions have been restored.

2.17 VOICE EVACUATION shall be provided in all group A Occupancies with an occupancy load of 1,000 or more and shall be activated by the fire alarm system. Voice communication system shall be CFSM listed and approved. System shall provide an approved prerecorded message announcement that is audible above the ambient noise.

PART 3 - EXECUTION

- 3.1 All wiring shall be (min) #18 AWG copper or as noted on drawings. All underground conductors shall be UL wet location rated for use in wet locations, West Penn "Aquaseal" or equal. There shall be no splices in underground handholes or vaults. A multi-conductor cable rated for use in wet locations will also be acceptable. It must be labeled "FIRE ALARM" in all pull boxes, using a water-tight labeling system.
- 3.2 Interior, dry location wiring for low voltage initiating circuits shall be #18 AWG copper, twisted shielded pair minimum, signaling circuits shall be No. 14 AWG minimum, and wiring for 120 volt circuits shall be No. 12 AWG minimum. All wiring shall be color coded, solid copper conductor. Use of power limited cable shall be restricted to controls listed for this purpose. Single conductors shall be type THHN/THWN-2 insulated copper.
- 3.3 Wire markers shall be provided for each wire connected to equipment. The marker shall be of the taped bank type, of permanent material, and shall be suitable and permanently stamped with the proper identification. The markers shall be attached in a manner that will not permit accidental detachment. Changing of wire colors within circuits shall be unacceptable.
- 3.4 A terminal cabinet shall be installed in the electric room for the fire alarm systems at each building. All fire alarm wiring shall terminate on UL approved strips in this terminal cabinet. All wiring shall be labeled at each termination strip. Wiring shall be configured such that all end-of-line resistors will be installed at the terminal cabinet.
- 3.5 Fire Sprinkler Activation detecting System(s) shall each be indicated on a separate zone in the fire alarm control panel.
- 3.6 Fire Alarm Control Panel and all other equipment shall be mounted with the center of all operable reset buttons, located a maximum of 48" front approach / 54" side approach above floor level.
- 3.7 Contractor shall provide complete wiring between all equipment.
- 3.8 The Fire Alarm/Life Safety Installation shall comply fully with all Local, State and National Codes, and the Local Authority Having Jurisdiction (AHJ) DSA.

- 3.9 The Fire Alarm Control Panel and power supply shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main Power Distribution Panel as FIRE ALARM CIRCUIT.
- 3.10 The Control Panel Cabinet shall be grounded securely to a power system ground conductor. Provide a 1/2-inch conduit and 1#12 grounding conductor to the building electrical service ground bus.
- 3.11 Conduit shall enter into the Fire alarm Control Panel back box only at those areas of the back box which have factory conduit knockouts.
- 3.12 All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; an audible and visual trouble signal will be activated until the system and its associated field wiring are restored to normal condition.
- 3.13 All cables and wiring shall be listed for Fire Alarm/Life Safety use and shall be of the type as required by and installed per CEC Article 760.
- 3.14 Refer to the MEP Component Anchorage and Piping, Ductwork and Electrical Distribution System Bracing notes on the drawings.
- 3.15 Final System Acceptance
 - 3.15.1 Provide an NFPA Certificate of Compliance to DSA, the School District and Local Fire Marshall. Complete fire alarm system shall comply with and be sound-tested for a "Temporal Pattern" in all zones.
 - 3.15.2 Beam detectors shall be tested by two methods:
 - 3.15.2.1 Manual slow cover test to confirm reflector alignment is correct.
 - 3.15.2.2 Software fire test per UL268.5 to demonstrate when signal level is reduced simulating obstruction the detector will go into alarm.
 - 3.15.3 The system will be accepted only after a satisfactory test of the entire system has been accomplished by a Factory-Trained Distributor in the presence of a representative of the authority having jurisdiction and the Owner's representative. This contractor shall provide all personnel, ladders and testing equipment to assist the local authority in completing this test. Actuate each device and verify that the system performs as specified.
 - 3.15.4 The Contractor will present a complete set of "as-built" Fire Alarm/Life Safety system drawings, and the factory supplied Operator's Manuals as required by the General Provisions section of this specification.

- 3.15.5 Once the system has been tested and the certificate of compliance completed, the contract shall not be considered complete until after owner training has been completed. The contractor shall notify in writing their intent to provide the training for the system. This notification shall be given to the Division 21 Contractor, Architect and the Project Engineer a minimum of 2 weeks prior to the scheduled training session. The Division 21 Contractor and/or the architect shall be responsible for notifying the owner to confirm that the appropriate District personnel will be made available for this training session. If the Division 21 Contractor does not receive confirmation that the training session can be performed on the proposed date, than another time shall be provided. The training shall consist of the following:
 - 3.15.5.1 Provide a minimum of one (1) four-to-six -hour training period located at the project site, to instruct District personnel in proper operation of all systems.
 - 3.15.5.2 Provide a minimum of three (3) complete owner operation manuals for the District records.
 - 3.15.5.3 Provide a minimum of two (2) complete as built sets of drawings for the District records.
 - 3.15.5.4 Provide all spare parts as described in part 1 of these specifications
 - 3.15.5.5 Provide written confirmation and proposed scheduled dates for follow up training and 1 year complete system test.
- 3.16 Follow up Training
 - 3.16.1 Provide as a part of this contract, the follow up instructional training period within six (6) months after the final acceptance of the systems. This training shall include a minimum of one four-to-six-hour training period to instruct District personnel in proper operation of all systems and shall instruct the District technicians how to repair any non-operational parts of the system as required. All defective parts shall be replaced at no cost to the owner.

END OF SECTION

SECTION 31 23 17

TRENCHING

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Excavate trenches for utilities.
 - B. Compacted bedding.
 - C. Backfilling and compaction to required elevations.
 - D. Slurry concrete.
 - E. Thrust Blocks.

1.02 REFERENCES

- A. ASTM C150 Portland Cement.
- B. ASTM C494 Chemical Admixtures for Concrete.
- C. ASTM D1557 Laboratory compaction characteristics of soil using modified effort.
- D. SSPWC Standard Specifications for Public Works Construction, Latest Edition.
- E. California Code of Regulations, Title 8, Industrial Relations, Construction Safety Orders, Division 01, Chapter 4, Sub-Chapter 4, Article 6 Excavations.
- F. California Public Contract Code, Section 7104 Public Works Contracts for Digging Trenches or Excavations; Notice on Discovery of Hazardous Waste or Other Unusual Conditions; Investigations; Change Orders; Effect on Contract.
- G. California Labor Code, Section 6705 Public Works Contracts requiring detailed plans for shoring, bracing, sloping, indicating protection from caving ground for trenching work in excess of 5' deep and contract amounts stipulated therein.

1.03 QUALITY ASSURANCE

- A. Verify survey benchmark and intended elevations for Work.
- B. Borrow. Fill, backfill, aggregate base, and other soil materials obtained from off-site sources shall be sampled and tested in compliance with CA EPA Department of Toxic Substances Control recommendations to prevent the importation of contaminated materials to the Site.
 - 1. Testing Frequency
 - a. For borrow up to 1,000-cu.yd, conduct 1 test for each 250-cu.yrds.

- b. For borrow between 1,001- and 5,000-cu.yrd; conduct 4 tests for first 1,000- cu.yrd, if material tests acceptable, conduct 1 test for each additional 500-cu.yrds.
- c. For borrow over 5,000-cu.yrds, conduct 12 tests during import of first 5,000-cu.yrd, if material tests acceptable, conduct 1 test for each additional 1,000-cu.yrds.
- 2. Owner's Testing Laboratory shall take samples at source, conduct testing and evaluate test results prior to delivery.
- 3. Conduct tests for lead and other heavy metals, asbestos, PCB's, pesticides, herbicides, VOCs, and semi-VOCs.
- 4. When detectable quantities of hazardous materials are found, determine the risk to human health, the environment, or both using the DTSC Preliminary Endangerment Assessment Guidance Manual.
- 5. Do not import soils that exhibit a known risk to human health, the environment, or both.

1.04 SOILS INFORMATION

A. Geotechnical Investigation has been prepared under direction of Owner. Investigation is hereby referenced as information for Work of this Section. Architect assumes no responsibility for conclusions Contractor may draw from information provided. The Contract Documents take precedence over recommendations that may be contained in the Investigation and the contractor must obtain approval for any and all deviations from the Contract Documents. Copy of investigation is available at Architect's office.

PART 2 - PRODUCTS

2.01 FILL AND BEDDING MATERIALS

- A. Sand: Sand shall consist of natural or manufactured granular material, or a combination thereof, free of deleterious amounts of organic material, mica, loam, clay and other substances not suitable for the purpose intended. Conform to Subsection 200-1.5.5, SSPWC, for gradation as required for Portland Cement Concrete, sand must achieve compaction of a minimum 90 percent.
- B. Imported Fill: Granular, free of debris, no gravel larger than 3 inches in any dimension, non-expansive, approved by the Architect prior to placement on the site.
- C. Slurry Concrete:
 - 1. Slump: Between 4 inches and 6 inches.
 - 2. Aggregate: 40 percent sand by weight, 60 percent pea gravel, minimum 1/4 inch, maximum 5/8 inch.
 - 3. Portland Cement: ASTM C150, 2-sack mix (2 sacks of cement per cubic yard).]
 - 4. Admixture: Calcium Chloride free, in proportions not to exceed the manufacturer's recommendations.
 - 5. Artificial Coloring: ASTM C494. Mix in Mapico Red pigment, proportions as recommended by the manufacturer, L.M. Scofield or equal.

- 6. Sufficient water shall be added to produce a fluid, workable mix that will flow and can be pumped without segregation of aggregate. Material shall be mechanically mixed until the cement and water are thoroughly dispersed.
- D. Stockpiled Fill: Onsite soils, stored separately on the site, approved for re-use by the Architect.
- E. Thrust Blocks: Concrete per Section 32 13 13.
- 2.02 ACCESSORIES
 - A. Underground Warning Tape: Metallic Detection Tape, aluminum core, 6 inches wide AASHTO specification colors, by Safety Sign Company, Cleveland, OH, or equal.
 - B. Color Coding and Lettering: as required for type of underground utility.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify fill material to be reused is acceptable to the Geotechnical Engineer.

3.02 PREPARATION

- A. Identify required lines, levels, contours and datum.
- B. Backfill with approved fill and compact to density equal to or greater than requirements for subsequent backfill material.
- C. Prior to commencement of trenching operations, notify Underground Service Alert of Southern California (800) 422-4133, Monday through Friday, 7:00 A.M. to 5:00 P.M.

3.03 EXCAVATION

- A. Conform to Construction Safety Orders, Title 8, CCR, For Sloping, Benching, Shoring, Bracing, Protective Systems, and Shafts.
- B. Conform to Section 7104, Public Contract Code. Promptly notify Owner of any contact with hazardous materials or differing conditions.
- C. Conform to Section 6705, Labor Code. Provide shoring and bracing plan or other provisions intended to prevent caving ground.
- D. Excavate subsoil required for utilities. Trenches shall be level or parallel to finish grade unless designated on drawings to be installed to specific gradient.
- E. Cut trenches sufficiently wide to enable installation of utilities and allow inspection.

- F. Water, storm drainage piping located in the same trench shall be separated by 12 inches horizontally and vertically, and water line shall be placed on a solid shelf excavated on one side of the common trench. Cross-over water lines shall also be separated 12 inches vertically from storm drainage pipe.
- G. Water and sewer piping shall not be located in the same trench and they shall be separated by 12 inches horizontally and 12 inches vertically.
- H. Excavation shall not interfere with normal 45 degree bearing splay of foundations. Parallel trenches, no closer than 18 inches from building foundations.
- I. Hand trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
- J. Remove lumped subsoil, boulders and rock.
- K. Correct unauthorized excavation.
- L. Stockpile approved excavated material in area designated on site and remove excess material not being used from site.

3.04 BEDDING

- A. Support pipe and conduit during placement and compaction of bedding fill. Provide uniform bearing along entire length. Conform to Section 306, SSPWC.
- B. Bedding: Place and compact materials in continuous layers not exceeding 6 inches compacted depth, ASTM D1557.
- 3.05 BACKFILLING
 - A. Backfill trenches to contours and elevations with unfrozen materials.
 - B. Fill areas will be inspected, tested and approved by Geotechnical Engineer.
 - C. Soil Fill over Bedding: Place and compact material in continuous layers as scheduled, compacted to ASTM D1557.
 - D. Employ placement method that does not disturb or damage conduit, ducts or piping in trench.
 - E. Maintain optimum moisture content of backfill materials to attain required compaction density. When operations are interrupted by rain, do not resume Work until field tests indicate that moisture content and density of fill are as previously specified.
 - F. Remove surplus backfill materials from site and dispose legally.
 - G. Leave fill material stockpile areas completely free of excess fill materials.
 - H. Minimum Cover Over Piping, Conduits or Duct Banks: 24 inches.

- I. Lay out and install or otherwise confirm invert elevations of all gravity flow systems to avoid conflict with other sub-surface structures or utilities of any kind. Adjust elevations or layout of pipes, conduits or duct banks to permit the required gravity flow.
- J. Jetting for utility trenching compaction may be used outside building perimeter and only when recommended by Geotechnical Engineer, in accordance with Section 306 SSPWC.
- K. Pressurized piping shall be installed level, or shall be installed parallel to finish grades unless designated on the Drawings to be installed to specific gradients.
- 3.06 THRUST BLOCKS
 - A. Install at turns of water lines and as indicated in drawings.
- 3.07 TOLERANCES
 - A. Top Surface of Backfilling Under Paved Areas: 0.2 ft from required elevations.
 - B. Top Surface of General Backfilling: Plus or minus 0.2 ft from required elevations.
- 3.08 FIELD QUALITY CONTROL
 - A. Backfill materials and operations will be inspected and approved by Geotechnical Engineer including earth bank slopes (cut or fill).
 - B. Tests, analysis and compaction of fill material will be performed in accordance with ASTM D1557.
 - C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
 - D. Frequency of Tests: Geotechnical Engineer may make as many tests as are necessary to ensure specified results.
- 3.09 PROTECTION OF FINISHED WORK
 - A. Protect finished Work.
 - B. Recompact fills subjected to vehicular traffic.
- 3.010 TEMPORARY PROTECTION OF UNFINISHED WORK
 - A. Trenching for placement of underground utilities shall be covered and protected with steel trench plates during non-work hours and during school session hours. Adequate warnings and protection indication of open trenches during work hours must be provided for project safety.
- 3.011 SCHEDULE

- A. Storm and Sanitary Piping:
 - 1. Bedding Fill: Sand, minimum thickness below piping 0.4 times outside diameter of pipe but no less than 4 inches. Minimum thickness above top of piping, 12 inches, compacted to 90 percent.
 - 2. Cover with stockpiled fill in 8-inch lifts to specified subgrade elevations, compact to 90 percent or to 95 percent under vehicle traffic-supporting paved areas.
 - 3. Fill: Slurry concrete, 6" cover at top, bottom and sides of pipes at exterior paved areas (at vehicle traffic) where minimum fill cover is less than 12" below finished elevation of paving.
 - 4. Bury warning tape marked "Caution Sewer Line" 12 inches above all concreteencased piping. Align tape parallel to and within 3 inches of the centerline of the piping.
- B. Power Ducts: Concrete Encased
 - 1. Fill: Slurry concrete, 3 inches cover at top, bottom, between conduits and sides of duct bank.
 - 2. Fill: Slurry concrete, 6 inches cover at top, bottom and sides of duct bank conduit at exterior paved areas where minimum fill cover is less than 24" below finished elevation of paving, less than 12" below finished elevations of interior floor slabs and at building footings where conduit is in the footing structural splay.
 - 3. Install two No. 4 bars in slurry concrete at top of bank under paved areas, minimum 3 inch concrete cover.
 - 4. Cover with stockpiled fill in 6-inch lifts to specified subgrade elevation, compact to 90 percent, or to 95 percent under traffic-supporting paved areas.
 - 5. Bury warning tape marked "Caution Buried High Voltage Line" 12 inches above all concrete-encased duct banks. Align tape parallel to and within 3 inches of the centerline of the duct bank.
- C. Water Piping and Gas Piping:
 - 1. Bedding Fill: Sand, minimum thickness below piping 0.4 times outside diameter of pipe but not less than 4". Minimum thickness above top of piping, 6 inches, compacted to 90 percent.
 - 2. Fill: Slurry concrete, 6 inches cover at top, bottom and sides of pipes at exterior paved areas where minimum fill cover is less than 24" below finished elevation of paving, and less than 12" below finished elevations of interior floor slabs and at building footings where piping is in the footing structural splay.
 - 3. Cover with stockpiled fill in 6-inch lifts to specified subgrade elevation, compact to 90 percent, or 95 percent under traffic-supporting paved areas.
 - 4. Observe joints at pressure tests.
 - 5. Bury warning tape marked "Caution Buried Gas (or "Pipeline") Line" 12 inches above all trenching. Align tape parallel to and within 3 inches of the centerline of trench.
- D. Fire Lines:
 - 1. Bedding Fill: Manufactured Sand, minimum 6" thickness under piping, minimum thickness above top of piping and sides, 6", compact to 90 percent.
 - 2. Fill: Slurry concrete, 6" cover at top pipes at exterior paved areas where minimum fill cover is less than 24" below finished elevation of paving.

- 3. Cover with stockpiled fill in 6-inch lifts to specified subgrade elevation, compact to 90 percent, or 95 percent under traffic-supporting paved areas.
- 4. Bury warning tape marked "Caution Buried Pipeline" 12 inches above all trenching. Align tape parallel to and within 3 inches of the centerline of trench.
- E. Low Voltage Conduits and Communications: Direct Burial Minimum trench depth 36 inches.
 - 1. Bedding Fill: Sand, 6 inches at bottom, sides and 12 inches on top, compacted to 95 percent.
 - 2. Cover with stockpiled fill in 6-inch lifts to specified subgrade elevation, compact to 90 percent, or 95 percent under traffic-supporting paved areas.
 - 3. Bury warning tape marked "Caution Buried Communication Line Below" 12 inches above conduits. Align tape parallel to and within 3 inches of the centerline of conduits.

END OF SECTION

SECTION 31 23 23

BACKFILLING

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Authorized types of fill.
 - B. Building area backfilling to subgrade elevations.

1.02 REFERENCES

- A. ASTM D1557 Laboratory compaction characteristics of soil using modified effort.
- B. SSPWC Standard Specifications for Public Works Construction, Latest Edition.
- C. Chapter 18A and 33, California Building Code.
- D. CSS Caltrans Standard Specifications, Latest Edition.

1.03 SUBMITTALS

- A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D 2487 of each [on-site] [and] [borrow] soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D 1557 for each on-site [and] [borrow] soil material proposed for fill and backfill.
- B. [Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.]

1.04 QUALITY ASSURANCE

- A. Borrow. Fill, backfill, aggregate base, and other soil materials obtained from off-site sources shall be sampled and tested in compliance with CA EPA Department of Toxic Substances Control recommendations to prevent the importation of contaminated materials to the Site.
 - 1. Testing Frequency
 - a. For borrow up to 1,000-cu.yrd, conduct 1 test for each 250-cu.yrds.
 - b. For borrow between 1,001- and 5,000-cu.yrd; conduct 4 tests for first 1,000- cu.yrd, if material tests acceptable, conduct 1 test for each additional 500-cu.yrds.

- c. For borrow over 5,000-cu.yrds, conduct 12 tests during import of first 5,000-cu.yrd, if material tests acceptable, conduct 1 test for each additional 1,000-cu.yrds.
- 2. Owner's Testing Laboratory shall take samples at source, conduct testing and evaluate test results prior to delivery.
- 3. Conduct tests for lead and other heavy metals, asbestos, PCB's, pesticides, herbicides, VOCs, and semi-VOCs.
- 4. When detectable quantities of hazardous materials are found, determine the risk to human health, the environment, or both using the DTSC Preliminary Endangerment Assessment Guidance Manual.
- 5. Do not import soils, that exhibit a known risk to human health, the environment, or both.

PART 2 - PRODUCTS

- 2.01 FILL MATERIALS
 - A. This Section establishes standards of quality for backfill materials to be used as approved by Geotechnical Engineer in accordance with Chapter 18A CBC, Section 1803A.2 and Appendix J Section J107, California Building Code, and as scheduled in other Sections of this specification.
 - B. Crushed Rock and Rock Dust: Crushed rock and rock dust shall be product of crushing rock or gravel. Portion of material that is retained on a 3/8 inch sieve shall contain at least 50 percent of particles having three or more fractured faces. Not over 5 percent shall be pieces that show no such faces resulting from crushing. Of that portion which passes 3/8 inch sieve but is retained on No. 4 sieve, not more than 10 percent shall be gravel particles. Crushed rock shall conform to 3/4 inch sieve size in accordance with Subsection 200-1.2, SSPWC, Crushed Rock Gradation Table.
 - C. Pea Gravel: Natural stone; washed, free of clay, shale, organic matter; graded to the following:
 - 1. Minimum Size: 1/4 inch.
 - 2. Maximum Size: 5/8 inch.
 - D. Sand: Sand shall consist of manufactured granular material, or combination thereof, free of deleterious amounts of organic material, mica, loam, clay and other substances not suitable for purpose intended. Conform to Section 200-1.5.5, SSPWC, for gradation as required for Portland Cement Concrete, sand must achieve compaction of a minimum 90 percent.
 - E. Crushed Aggregate Base: As specified in Section 32 12 16. Crushed rock and rock dust conforming to requirements of Section 200-1.2, SSPWC, with 3/8 inch sieve requirement waived, or Class 2 aggregate base as defined in Section 26, CSS.
 - F. Imported Fill: Clean granular, free of debris, no rock larger than 3 inches in any dimension, non-expansive, approved by Geotechnical Engineer prior to placement on site.

- G. Concrete: Structural, as specified in Section 03 30 00.
- H. Concrete Slurry: as specified in Section 31 23 17.
- I. Stockpiled Fill: On-site soils, stored separately on site, approved for re-use by Geotechnical Engineer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify fill materials to be reused or imported are acceptable to Architect.
- B. Verify foundation perimeter drainage installation has been inspected and approved.

3.02 BACKFILLING

- A. Backfill and compact areas to contours and elevations with unfrozen materials. Remove debris from areas to receive backfills.
 - 1. Compaction: ASTM D1557, Compact to 90 percent of maximum dry density.
 - 2. Floor slabs shall be in place a minimum of 7 days before backfill is placed against walls.
- B. Fill areas and types of fill shall be inspected, tested and approved by Geotechnical Engineer.
- C. Employ placement method that does not disturb or damage foundation perimeter drainage, foundation waterproofing and protective cover or utilities in trenches. Do not commence backfill until such work is in place, inspected and approved.
- D. Maintain optimum moisture content of backfill materials to attain required compaction density. When operations are interrupted by rain, do not resume work until field tests indicate that moisture content and density of the fill are as previously specified.
- E. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise.
- F. Make grade changes gradual. Blend slope into level areas.
- G. Remove surplus backfill materials from site.
- H. Leave fill material stockpile areas completely free of excess fill materials.
- I. Compaction Equipment: Wherever feasible, perform compaction with approved power-driven equipment such as rollers and sheeps-foot compactors. Compact areas inaccessible to rollers with pneumatic tampers or other approved compactors.
- J. Flooding and jetting is not permitted.
- 3.03 TOLERANCES

A. Top Surface of Backfilling Subgrade: Within 0.05 feet from required elevations.

3.04 FIELD QUALITY CONTROL

- A. No fill shall be placed on any prepared surface until that surface has been inspected and approved by Geotechnical Engineer.
- B. If tests indicate work does not meet specified requirements, remove work, replace and retest. Cost of retests shall be paid by Owner and deducted from contract sum by Change Order.
- C. Frequency of Tests: Architect may require as many tests as are necessary to ensure specified results.
- 3.05 PROTECTION OF FINISHED WORK
 - A. Protect finished Work.
 - B. Recompact fills subjected to and damaged by vehicular traffic.

END OF SECTION

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.2 SUMMARY
 - A. Section Includes:
 - 1. Hot-mix asphalt paving.
 - 2. Hot-mix asphalt paving overlay.
 - 3. Hot-mix asphalt patching.
 - 4. Asphalt surface treatments.
 - a. Seal coats.
 - b. Crack sealants.
 - 5. Pavement-marking paint.
 - B. Related Sections:
 - 1. Section 312000 Earth Moving.
- 1.3 SYSTEM DESCRIPTION
 - A. Provide hot-mix asphalt pavement according to the materials, workmanship, and other applicable requirements of the standard specifications of the State or of authorities having jurisdiction.
 - 1. Standard Specification: CalTrans
 - 2. Manual of Tests: CalTrans
 - 3. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- 1.4 DEFINITION
 - A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.
- 1.5 SUBMITTALS
 - A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
 - 1. Job-Mix Designs: For each job mix proposed for the Work. Provide



certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

- B. Material Certificates: For each paving material, signed by manufacturer certifying that each material complies with requirements.
- C. Material Test Reports: For each paving material.
- 1.6 QUALITY ASSURANCE
 - A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of California Department of Transportation (CalTrans) for asphalt paving work.
 - 1. Comply with requirements of local jurisdictions where more stringent than CalTrans requirements.
 - 2. Measurement and payment provisions and safety program submittals included in CalTrans standard specifications do not apply to this Section.
 - B. Regulatory Requirements: Comply to applicable standards of the San Diego County Air Pollution Control District for quantities of volatile organic compounds (VOC) used in all materials.
- 1.7 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
 - B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.
- 1.8 PROJECT CONDITIONS
 - A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Prime Coat: Minimum surface temperature of 60 deg F.
 - 2. Tack Coat: Minimum surface temperature of 60 deg F.
 - 3. Seal Coat: Comply with weather limitations of ASTM D 3910
 - 4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
 - B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

1. 40 deg F for oil-based materials.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Base Coarse Aggregate: Class 2 Aggregate Base mineral aggregate, 3/4 inch maximum size, as specified in CalTrans Standard Specifications.
 - 1. Recycled asphalt paving may be used as base course aggregate, subject to complying with CalTrans Standard Specifications.
- C. Asphalt Aggregate: Type B Aggregate, as specified in CalTrans Standard Specifications.
 - 1. 3/4 inch maximum size for base course.
 - 2. 1/2 inch maximum size for surface course.

2.2 ASPHALT MATERIALS

- A. Asphalt Cement: Steam Refined, penetration-graded material. AR-8000 or AR-4000 conforming to CalTrans Standard Specifications.
- B. Prime Coat: Asphalt emulsion prime coat complying with CalTrans.
- C. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- D. Seal Coat: Emulsified asphalt with a minimum 2% 3% latex or copolymer added with 2-4 lbs of grade #30 silica sand added per gallon and mechanically agitated.
- E. Water: Potable.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the Environmental Protection Agency (EPA). Provide in granular, liquid, or wettable powder form.
- B. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.
- C. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

- D. Crack Sealer: Rubberized joint sealant complying with Federal Standards ASTM D5329 Parking Lot Crack Sealer.
- E. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II.
 - 1. Color: As indicated.
- 2.4 MIXES
 - A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
 - 1. Comply with CalTrans Standard Specifications.
 - 2. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 - EXECUTION

- 3.1 EXAMINATION
 - A. Ensure that any air handling system that is likely to ingest fumes is protected and that windows near paving operations are closed.
 - B. Verify that subgrade is dry and in suitable condition to begin paving.
 - C. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
 - D. Notify Architect in writing of any unsatisfactory conditions. Proceed with paving only after unsatisfactory conditions have been corrected.
 - E. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.
- 3.2 COLD MILLING
 - A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to

grades and cross sections indicated.

- 1. Repair or replace curbs, manholes, and other construction damaged during cold milling.
- 2. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
- 3. Keep milled pavement surface free of loose material and dust.

3.3 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
 - 1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions, and in compliance with the District Pest Control specifications where more stringent. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- C. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure for 72 hours minimum.
 - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.
- D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 PAVING GEOTEXTILE INSTALLATION

- A. Apply asphalt binder/cement, consisting of solvent-free emulsified asphalt, uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd.
- B. Place paving geotextile promptly according to manufacturer's written



instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.

1. Protect paving geotextile from traffic and other damage and place hotmix asphalt paving overlay the same day.

3.5 BASE COURSE

- A. Install paving geotextile on prepared subgrade or subbase according to manufacturer's written instructions, overlapping sides and ends.
- B. Place base course on separation fabric according to manufacturer's written instructions and as follows:
 - 1. Compact base courses at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
 - 2. Shape base to required crown elevations and cross-slope grades.
 - 3. When thickness of compacted base course is 6 inches or less, place materials in a single layer.
 - 4. When thickness of compacted base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches or less than 3 inches thick when compacted.

3.6 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. When thickness of asphalt course is 4 inches or less, place materials in a single layer.
 - 2. When thickness of asphalt course exceeds 4 inches, place material in equal layers, with no layer more than 4 inches or less than 2 inches thick when compacted.
 - 3. Spread mix at minimum temperature of 250 deg F.
 - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill

depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.7 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to a density within 2 percent of specified course density.
- 3.8 COMPACTION
 - A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
 - B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Use a vibratory roller with dynamic force of 93,000 lbs, or weighing 21,000 lbs. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevations. Correct laydown and rolling operations to comply with requirements.
 - C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density, using one of the following methods as acceptable to the authority having jurisdiction:
 - 1. Average Density (Marshall Test Method): 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
 - 2. Average Density (Rice Test Method): 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90



percent nor greater than 96 percent.

- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.
- 3.9 ASPHALT SPEED BUMPS
 - A. Construct asphalt speed bumps over compacted pavement. Apply a light tack coat to compacted pavement unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F.
 - 1. Asphalt Mix: Same as pavement surface-course mix.
 - B. Place hot-mix asphalt to speed bump cross section as indicated.
- 3.10 INSTALLATION TOLERANCES
 - A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
 - B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.
- 3.11 CRACK REPAIR
 - A. Remove vegetation and treat with herbicide.
 - B. Rout cracks in accordance with SHARP H348 and H349.

- C. Fill cracks with hot-applied joint sealant. Apply with a wand from a double jacketed melter.
 - 1. Over-fill cracks and squeegee level with pavement.

3.12 SURFACE TREATMENTS

- A. Seal Coat: Apply first coat at rate of 0.125 to 0.185 gal./sq. yd. After first coat has dried, apply second coat at rate of 0.100 to 0.185 gal./sq. yd.
 - 1. Seal coating new pavements should be delayed 6-12 months after installation or as recommended by manufacturer.
 - 2. Preparation: All area shall be power-swept, vacuumed and cleared of loose material.
 - 3. Standing water shall be spread out and allowed to dry. Do not apply seal coat to wet or damp surfaces.
 - 4. Oil spots shall be manually scraped and cleaned with a mild detergent. Apply primer over highly saturated petroleum areas.
 - 5. Cover and protect items within paved area that are not to be coated, such as valve boxes, manholes and concrete.
- B. Fog Seals: Apply fog seal at manufacturer's recommended rate, but not less than 0.30 gal./sq. yd. to existing asphalt pavement and allow to cure. Apply in multiple coats. With fine sand, lightly dust areas receiving excess fog seal.
 - 1. Fog coating new pavements should be delayed 12 months after installation or as recommended by manufacturer unless pavement is showing severe raveling.
 - 2. On extremely rough surfaces, provide sand fill for base application where recommended by manufacturer.

3.13 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for 30 days before starting pavement marking, unless otherwise acceptable to the paint manufacturer.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
- 3.14 FIELD QUALITY CONTROL
 - A. Testing Agency: District will engage a qualified independant testing agency to perform field tests and inspections and to prepare test reports.

- B. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.
- 3.15 DISPOSAL
 - A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow milled materials to accumulate on-site.

END OF SECTION 321216

SECTION 32 13 13

SITEWORK CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Cast-In-Place concrete pedestrian paving and sidewalks.
 - 2. Curbs and gutters.
 - 3. Concrete stairs, ramps and landings.
 - 4. Light standard bases, and similar site structures.
 - 5. Utility concrete pads.
 - 6. Perimeter concrete curbing, mow strips, concrete drainage structures, swales.
 - 7. Integral Color concrete.
 - 8. Thrust Blocks.
 - 9. Slurry Concrete.
- B. Related Sections:
 - 1. Section 31 23 16 Excavation.
- 1.02 REFERENCES
 - A. ACI 117 Standard Specifications for Tolerances for Concrete Construction and Materials.
 - B. ACI 318 Building Code Requirements for Structural Concrete and Commentary, 2005 Edition.
 - C. ACI 301 Structural Concrete for Buildings.
 - D. ASTM American Society for Testing and Materials
 - 1. ASTM A185 Steel Welded Wire Reinforcement, Plain, for Concrete
 - 2. ASTM A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
 - 3. ASTM C33 Concrete Aggregates
 - 4. ASTM C94 Ready-Mixed Concrete
 - 5. ASTM C150 Portland Cement
 - 6. ASTM C171 Sheet Materials for Curing Concrete
 - 7. ASTM C309 Liquid Membrane-Forming Compounds for Curing Concrete
 - 8. ASTM C618 Coal Fly Ash and Raw or Calcinated Natural Pozzolan for use as a Mineral Admixture on Concrete
 - 9. ASTM C920 Elastomeric Joint Sealants
 - 10. ASTM C979 Pigments for Integrally Colored Concrete
 - 11. ASTM C1107 Packaged Dry, Hydraulic Cement Grout (Non-Shrink)

- 12. ASTM D1751 Preformed Expansion Joint Fillers for Concrete, Paving and Structural Construction
- E. CBC 2007 California Building Code and Supplements
 - 1. CBC-11 CBC Chapter 11B, Accessibility to Public Buildings, Public Accommodations, Commercial Facilities and Publicly Funded Housing
 - 2. CBC-17 CBC Chapter 17, Structural Tests and Special Inspections
 - 3. CBC-19 CBC Chapter 19A, Concrete(for DSA)
- F. CACRM California Accessibility Compliance Reference Manual, updated based on 2007 California Building Code
- 1.03 SUBMITTALS
 - A. Placement Schedule for approval: Provide details or sketches showing location of each placement of concrete Work. Do not deviate from location of expansion joints or scorelines.
 - B. Product data on joint filler, sealants, curing compounds and reinforcing.
 - C. Project Record Documents
 - 1. Accurately record actual locations of embedded sleeves, utilities and components that are concealed from view.
 - D. Submit Certification of experience for Color finisher.
- 1.04 REGULATORY REQUIREMENTS
 - A. Pedestrian walks, plazas and paving shall comply with CBC-11B, Sections 1133B.7.1.1, and 1133B.7.2. Architect has relied on CACRM published by DSA in its interpretation of these regulations.
- 1.05 QUALITY ASSURANCE
 - A. Maintain one copy of all records on site.
 - B. Acquire cement and aggregate from same source for all Work.
 - C. Conform to Section 1905A.13, California Building Code, when placing concrete during hot weather.
 - D. Conform to Section 1905A.12, California Building Code, when placing concrete during cold weather. No placement of concrete permitted below 50 degrees Fahrenheit.
 - E. Mock-up
 - 1. Install minimum 5 feet by 5 feet mock-up of concrete sidewalk for each surface treatment specified.
 - 2. Install mock-up one month prior to installation.
 - 3. Locate as approved by the Architect.
 - 4. Use identical forming system, sub-grade type, reinforcing, expansion joints, score joints, finishing and edge trim as specified for installation.
 - 5. Architect approval required.

- 6. Mock-up may not be used in final installation.
- 7. Remove mock-up materials from site and dispose legally.

PART 2 - PRODUCTS

- 2.01 CONCRETE MATERIALS
 - A. Cement: ASTM C150 Type I Normal or Type II Moderate, Portland Cement type, from one manufacturing plant only.
 - B. Aggregates: ASTM C33, single source for all materials. Maximum size aggregate: 1 inch.
 - C. Non-Shrink Grout: ASTM C1107, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 4,000 psi in 24 hours and 7,500 psi in 7 days unless otherwise indicated on Drawings; of consistency suitable for application and a 30 minute working time.
 - D. Crushed Aggregate Base: [As specified in Section 32 12 16.] Crushed rock and rock dust conforming to requirements of Section 200-1.2, SSPWC, with 3/8 inch sieve requirement waived, or Class 2 aggregate base as defined in Section 26, CSS.
- 2.02 ACCESSORIES
 - A. Expansion Joints:
 - 1. Expansion Joint Filler ASTM D1751: Closed cell, 1/2 inch max. thick; FIBER EXPANSION JOINT by American Highway Technology, Kankakee, IL, DECK-O-FOAM by W. R. Meadows, or approved equal.
 - 2. Joint Devices: Integral extruded polystyrene plastic; 1/2 inch max. thick, with removable top strip exposing sealant trough; JOINT CAPS.
 - 3. Sealant: Polyurethane two-component type, self-leveling, for level surface application, UREXPAN NR-200 or DYNATRED for sloped surfaces, manufactured by Pecora Corp., Harleysville PA, or equal. Color shall be selected by Architect from manufacturer's standard list of colors.
 - 4. Primer: As recommended by sealant manufacturer.
 - 5. Joint Backing: ASTM C1330, Cylindrical, Type C, closed cell, polyethylene backer rod; oversized 30 to 50 percent larger than joint width. Green Rod by Nomaco Inc. or equal.

2.03 CONCRETE MIX

- A. Mix and deliver concrete in accordance with Section 1905A, California Building Code. Deliver concrete in transit mixers only. Mix concrete for 10 minutes minimum at a peripheral drum speed of approximately 200 feet per minute. Mix at jobsite minimum 3 minutes. Discharge loads in less than 1-1/2 hours or under 300 revolutions of the drum, whichever comes first, after water is first added.
 - 1. Design Mix:

- a. Conform to Section 1905A.3, 2007 California Building Code for Proportioning on the basis if field experience or trial mixtures method.
- b. Method B, Section 1905A.2.3. CBC 2001
- c. Conform to Section 1905 and Table 19-A-6, UBC.
- 2. Do not exceed 0.50 water-cement ratio by weight for floor slabs and for other concrete.
- 3. Quantities of Materials: Weighmaster's records not required for sitework concrete.
- 4. Required Strength: Minimum 2,500 psi for sitework concrete.
- B. Fly ash shall be used at 15% maximum replacement of the Portland cement at a 1:1 replacement ratio by weight. Fly Ash shall meet the requirements of ASTM C 618 with the exception that the Loss on Ignition shall not exceed 1.0 percent. Only Class F material is permitted.
- C. [Slurry Concrete:
 - 1. Slump: Between 4 inches and 6 inches.
 - 2. Aggregate: 40 percent sand by weight, 60 percent pea gravel, minimum 1/4 inch, maximum 5/8 inch.
 - 3. Portland Cement: ASTM C150, 2-sack mix (2 sacks of cement per cubic yard).
 - 4. Sufficient water shall be added to produce a fluid, workable mix that will flow and can be pumped without segregation of aggregate. Material shall be mechanically mixed until the cement and water are thoroughly dispersed.]
- 2.04 REINFORCEMENT
 - A. Reinforcing Steel: ASTM A615; 60 ksi yield grade; deformed billet steel bars, uncoated finish.
 - B. Welded Wire Reinforcement: Plain type, ASTM A185; in flat sheets; uncoated finish, 6 x 6 W4.0 x W4.0 unless otherwise note on drawings.
 - C. Tie Wire: Annealed steel, minimum 16 gage size.
 - D. Dowels: ASTM A615; 60 ksi yield grade, plain steel, uncoated finish.
- 2.05 FORMS
 - A. Conform to Section 1906A.1 and 1906A.2, California Building Code.
 - B. Plywood Forms: APA Medium density overlay, Group 1, Exterior, PS-1, for exposed surfaces. APA Plyform B-B, Class 1, Exterior, PS-1 for unexposed surfaces.
 - 1. Use flexible or curved forms for curves with a radius 100 feet or less.
 - C. Lumber: Douglas Fir species, construction grade, Surfaced Lumber, with grade stamp clearly visible for smooth and straight exposed surface.
 - D. Form Release Agent; commercially formulated form-release agent that will not bond with, stain or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.06 CURING MATERIALS

- A. Polyethylene Film ASTM C171; 10 mil thick, clear, manufactured from virgin resin with no scrap or additives, manufactured by Burke-Edoco, Long Beach, CA, or equal as approved in accordance with Division 01, General Requirements for Substitutions.
- B. Water: Potable and not detrimental to concrete.
- C. Curing Compound for Colored Concrete: ASTM C309, Type1, Class B; Water-base all resin curing compound-clear, by Burke-Edoco, Euclid Chemical Co. or equal. Curing materials and procedures for colored concrete in accordance with coloring material manufacturer's recommendations.

PART 3 - EXECUTION

- 3.01 EXAMINATION
 - A. Verify site conditions.
 - B. Verify requirements for concrete cover over reinforcement.
 - C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely and will not cause hardship in placing concrete.
- 3.02 PREPARATION
 - A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.
 - B. In locations where new concrete is doweled to existing Work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
- 3.03 PLACING CONCRETE (GENERAL)
 - A. Convey and deposit concrete in accordance with Section 1905A.9 and 1905A.10, California Building Code. Remove loose dirt from excavations.
 - B. Notify Job Inspector minimum 24 hours prior to commencement of operations.
 - C. Ensure reinforcement, inserts, embedded parts, formed joint fillers, joint devices and accessories are not disturbed during concrete placement.
 - D. Ensure sub-base or base materials have been compacted or otherwise treated.
 - 1. Sub-base and base preparation per Section 31 23 16 Excavation and Section 31 23 23 for Backfilling.
 - 2. Remove unsuitable soil, backfill with clean compactable soil or approve granular material to required elevations.
 - Scarify exposed natural sub-base to depth of 6 inches. Bring to optimum moisture content and re-compact to 90 percent in accordance with ASTM D 1557.

- 4. Add approved aggregated base to required elevation in 6 inch maximum lifts. Bring to optimum moisture content and compact to 90 percent in accordance with ASTM D1557.
- E. Install joint fillers, primer and sealant in accordance with manufacturer's instructions.
- F. Place concrete continuously between predetermined expansion joints.
 - 1. Install expansion joints at vertical concrete walls at 24 feet on center unless noted otherwise on drawings.
- G. Do not interrupt successive placement; do not permit cold joints to occur. Avoid segregation of materials. Perform tamping and vibrating so as to produce a dense, smooth application free of rock pockets and voids. Do not use vibrators to move concrete horizontally.
- H. Do not allow concrete to fall free from any height which will cause materials to segregate. Maximum height of free fall permitted in any case: 5 feet.
- I. Defective Installation: Repair and clean at Contractor's expense all concrete damaged or discolored during construction. Where concrete requires repair before acceptance, the repair shall be made by removing and replacing entire section between joints and not by refinishing the damaged portion.
- J. Proper curing of concrete surfaces is the responsibility of the Contractor. Concrete failing to meet specified strength shall be removed and replaced.
- 3.04 ON-SITE CONCRETE SIDEWALKS, PEDESTRIAN PAVED AREAS AND RAMPS
 - A. Forms, Wood: Free from warp, with smooth and straight upper edges, surfaced one side, minimum thickness 1-1/2 inches adequate to resist springing or deflection from placing concrete.
 - B. Forms, Metal: Gage sufficient to provide rigidity and strength equivalent to wood.
 - C. Reinforcing Steel: # 4 bars, place bars at 12 inches on center each way for sidewalks and paved areas and #4 bars for edges unless otherwise indicated on Drawings.
 - D. Concrete Placement: Dampen subgrade to retain moisture in concrete mix. Tamp and spade to consolidate concrete for entire length of pour. Strike off upper surface to specified grades.
 - E. Isolation Joints: Locate at slabs abutting vertical concrete surfaces and as patterned on drawings. Install vertically, full depth of concrete with preformed joint filler recessed for plastic cap at 1/2 inch depth at top for sealant application.
 - 1. Doweled Isolation Joints at Heavy Vehicle Driveways and Parking: At abutting building foundations; provide 1/2-inch diameter smooth steel dowels 14 inches long, one end of dowel lubricated and set in capped sleeve to allow for longitudinal movement, spaced at 24 inches on center maximum, 6 inches from edges.
 - 2. Monolithic Curb and Gutter: No expansion joints required between gutter and curb face.

- F. Expansion Joints: Locate maximum 24 feet centers and as patterned on drawings. Install vertically, full depth of concrete, install preformed joint filler recessed for plastic cap at 1/2 inch depth at top for sealant application.
 - 1. Monolithic Curb and Gutter: No expansion joints required between gutter and curb face.
- G. Contraction/Crack Control Joints: At 8 feet each way at concrete paved areas, and 5 feet at sidewalks, tool joint with 1/2 inch radius, depth 1/4 the thickness of slab but not less than 1 inch deep. Refer to drawings for required design patterns.
- H. Curb Ramps: Form grooves, flush to finished surfaces, 12" wide border. Grooves at 1/4" deep, 1/4" wide and at 3/4" on centers. at 3 sides on level surface of the sidewalk. Provide patterns as indicated in drawings.
 - 1. Detectable warning (Truncated Domes) required at curb ramps less than 1:15 (6.7% slope), DSA IR 11B-3
 - 2. Detectable Warnings (Truncated Domes) required at all Curb Ramps, American with Disabilities Act Standards for Accessibility Design Section 4.7.7.
 - a. Set Paver Truncated Dome products in full mortar bed per Section 32 14 13 Unit Pavers and as indicated on drawings.
 OR
 - a. Plastics/Composites: Cast in place plastic tiles per manufacturer's instructions and in accordance with CBC.
 - b. Form bottom edge flush and free of abrupt changes DSA IR 11B-2.
- I. Finish:
 - 1. Screed concrete to required grade, float to a smooth, flat, uniform surface. Edge all headers to 1/2 inch radius. Edge expansion joints to 1/4 inch radius. Steel trowel to hard surface.
 - 2. Grades less than 6 percent: shall conform to Section 1133B.7.1.1. After final troweling, apply a medium broom finish transverse to centerline or direction of traffic. Finish shall be at least as slip resistant as that described as a medium salted finish.
 - 3. Grades exceeding 6 percent: shall conform to Section 1133B.7.1.2. After final troweling, apply a heavy broom finish transverse to centerline or direction of traffic
 - 4. Walkway grades in excess of 5 percent shall conform to requirements of Section 1133B.7.3, California Building Code.
- J. Curing: Cure surfaces utilizing one of the following methods:
 - 1. Spraying: Spray water over slab areas and maintain wet for 7 days, use burlap mats.
 - 2. Spread polyethylene film over slab areas, lapping edges and sides, minimum 6 inches and sealing with pressure sensitive tape; cover with plywood or otherwise protect film from damage; maintain in place for 7 days.
 - 3. Apply liquid curing compound at rate of 200 sf per gallon, using power sprayer equipped with agitator. Do not apply liquid curing compound to surfaces scheduled to receive paving units of any kind.

- K. Remove expansion joint plastic caps. Prime both sides of joint and apply self-leveling sealant per Section 07 92 00. Provide smooth concave surface.
- L. Apply slip resistant finish in accordance with manufacturer's instructions on concrete ramp surfaces with slope in excess of 6 percent and all formed concrete stairs and landings:
 - 1. Float and trowel concrete once and allow to set until surface will support finisher's supports.
 - 2. Uniformly distribute grains over surface at the rate of 50 lbs. per 100 square feet.
 - 3. Imbed grains with a light wood float.
 - 4. Apply a light steel float. Do not trowel excessively. Grains shall remain visible in a uniform pattern.
- 3.05 LIGHT STANDARD BASES, MISCELLANUOUS SURFACES, UTILITY PADS, AND SIMILAR SITE STRUCTURES.
 - A. Forms: Suitable material and type, size, shape, quality and strength to insure construction as designed, true to line and sufficiently rigid to resist deflection during placing of concrete. Clean forms of all dirt, mortar and foreign matter before use.
 - B. Reinforcement: Place accurately and hold in position, using metal chairs, spacers, metal hangers, supporting wires and other devices of sufficient strength to resist crushing under full load. Clean reinforcing steel of mortar, oil, dirt, loose mill scale loose or thick rust and coatings.
 - C. Coordinate installation of conduits, cast in place items and other inserts.
 - D. Finish: Grind or sack as required as determined by the Architect to produce a smooth, straight, plumb and acceptable finish without burrs or form marks. For horizontal surfaces: provide float finish.
 - E. Curing: Cure surfaces utilizing one of the following methods:
 - 1. Spraying: Spray water over slab areas and maintain wet for 7 days.
 - 2. Spread polyethylene film over slab areas, lapping edges and sides, minimum 6 inches and sealing with pressure sensitive tape; cover with plywood or otherwise protect film from damage; maintain in place for 7 days.
 - 3. Apply liquid curing compound at rate of 200 square feet per gallon, using power sprayer equipped with agitator. Do not apply liquid curing compound to surfaces scheduled to receive paving units or finish of any kind.
 - F. Curing: Cure surfaces utilizing one of the following methods:
 - 1. Spraying: Spray water over slab areas and maintain wet for 7 days.
 - 2. Contractor's Option
 - a. Spread polyethylene film over slab areas, lapping edges and sides, minimum 6 inches and sealing with pressure sensitive tape; cover with plywood or otherwise protect film from damage; maintain in place for 7 days.
 - b. Apply liquid curing compound at rate of 200 square feet per gallon, using power sprayer equipped with agitator.

- G. [Install anti-slip tape at existing concrete stairs, all treads.]
- 3.06 CURB AND GUTTER, PERIMETER CONCRETE CURBING, MOW STRIPS CONCRETE DRAINAGE STRUCTURES AND SWALES
 - A. Subgrade Preparation: Subgrade material, base material and compaction requirements as approved by the Geotechnical Engineer.
 - B. Forms: Single face type required, cut to conform exactly with face batter and radius, sufficiently rigid to resist springing or deflection from concrete placement. Clean forms of all loose dirt, mortar or similar materials and apply a light coating of oil or other suitable material prior to concrete placement.
 - 1. Slip Forms: Contractor's option upon approval of the Architect.
 - C. Reinforcement: Refer to drawings for size and spacing. Interrupt reinforcement at expansion joints.
 - D. Concrete Placement: Dampen subgrade to retain moisture in concrete mix. Tamp and spade to consolidate concrete to entire length of pour. Strike off upper surface to specified grades. Cut drain pipes to conform to curb batter.
 - E. Expansion Joints: Locate joint filler at maximum 20 foot centers. Trim off excess filler material flush to finish surface. No sealant application required.
 - F. Control Joints: at 8 feet on center, tooled joints, 1/2 inch radius.
 - G. Finish: Apply thin layer of mortar of 1 part portland cement to 1-1/2 parts sand to exposed faces. Trowel to a smooth and even finish with a fine hair broom applied parallel with the line of the work. Round all edges to 1/2 inch radius. No Contractor identification permitted.
 - H. Curing: Cure surfaces utilizing one of the following methods:
 - 1. Spraying: Spray water over curb and gutter and maintain wet for 7 days.
 - 2. Spread polyethylene film over areas, lapping edges and sides, minimum 6 inches and sealing with pressure sensitive tape; cover with plywood or otherwise protect film from damage; maintain in place for 7 days.
 - 3. Apply liquid-curing compound at rate of 200 sf per gallon, using power sprayer equipped with agitator.
 - I. Running Track: imbed metal metric markers in concrete as laid out and require per Section 32 18 28 Synthetic Running Track Surfacing.
- 3.07 CONCRETE THRUST BLOCKS
 - A. Refer to drawings for locations.
 - B. Installed where the irrigation main changes direction as at ells and tees and where the irrigation main terminates. Pressure tests shall not be made for a period of 36 hours following the completion of pouring of the thrust blocks. Concrete thrust blocks for supply mains shall be sized and placed in strict accordance with the pipe manufacturer's

specifications and shall be of an adequate size and so placed as to take all thrust created by the maximum internal water pressure.]

3.08 COLORED CONCRETE ON-SITE SIDEWALKS AND CONCRETE AREAS

- A. Conform to On-Site Concrete Sidewalks and Concrete Areas procedures specified in this Section except where specified otherwise in this paragraph.
- B. Approved Manufacturer: Davis Colors, Inc., Los Angeles, CA, L.M. Scofield Company, Los Angeles, CA., or approved equal as approved in accordance with Division 01, General Requirements for Substitutions.
- C. Materials: Cement coloring dye for exterior concrete sidewalks, ASTM C979; integral, with natural and synthetic pigments and no artificial adulterants or fillers. Color as selected by the Architect from manufacturer's standard list.
- D. Weight Required: As recommended by the manufacturer for the color selected, in pounds of dye per sack of gray cement in the total batch. Add pigment by weight only, no visual proportioning permitted.
- E. Rinse mixer drum thoroughly before batching colored concrete.
- F. Add coloring agent directly to mixer at charging or mixing speed of 50 to 100 RPM for 5 to 10 minutes. Constant ratio of coloring agent to cement and materials required.
- G. Curing: Cure colored concrete surfaces strictly in accordance with the coloring material manufacturer's recommendations. Apply matching color sealer in accordance with Davis Data #CS 78-1. Do not apply polyethylene sheeting or intermittent wetting or drying.]

3.09 FINISH AT EXPOSED VERTICAL SURFACES

- A. Rubbed Finish: Apply the following to smooth-formed finished concrete per ACI 301:
 - 1. Grout-Cleaned Finish (Sack-rubbed finish): Remove fins, rough spots, stains, and hardened mortar by carefully rubbing with a fine abrasive stone to a smooth even surface. Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part Portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 - 2. [Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.]
 - 3. [Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part Portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface with slow-speed grinder. In a swirling motion, finish surface with a cork float.]

A. Sandblast Finish: Light sandblast where plywood or other smooth forms have been used, uniformly sand-blasted with sharp quartz sand under sufficient air pressure. Such surfaces shall be thoroughly washed with clear water after sandblasting.

3.10 SANDBLAST FINISH

- A. Sandblasted Exterior Concrete Finish: Per ACI 301, two-step trowel finish to dense, smooth surface, free from trowel marks and other blemishes.
 - 1. Perform sandblasting no sooner than 28 days after placement of each concrete section, ASTM D4259 Standard Practice for Abrading Concrete.
 - 2. Use backup boards to maintain uniform edges and corners.
 - 3. Use abrasive grit of suitable type and graduation to remove surrounding matrix and expose aggregate.
 - a. Medium Sand Blast Finish: Make medium cut, 1/8 inch deep.
 - b. Light Sand Blast Finish: Make Light cut, 1/16 inch deep.
 - c. Provide sample to Architect for approval.
 - 4. Evenly sandblast uncovered areas until concrete aggregate is exposed, to match reviewed sample.
 - 5. Perform sandblasting as continuous operation, utilizing same crew of workers, to maintain consistency.
 - 6. Use same nozzle, nozzle pressure and blasting technique as used for sample panel.
 - 7. Maintain control over abrasive grit and concrete dust. Provide covers and barriers as necessary to prevent dust from soiling and contaminating surrounding areas.
 - 8. Remove all expanded abrasive grit and concrete dust at the end of each work period, and dispose legally and properly off site.
 - 9. Such surfaces shall be thoroughly washed with clear water after sandblasting.]

3.11 TOLERANCES

- A. Construction tolerances shall not violate dimensions, grades, slopes required by CBC for accessibility requirements. Adjust work accordingly to comply with requirements.
- B. Comply with tolerances of ACI 117 and as follows (tolerances may not exceed CBC maximum or minimum):
 - 1. Maximum deviation of 1/8 inch in 10 feet.
 - 2. Elevation: 1/4 inch (6 mm).
 - 3. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
 - 4. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/8 inch (3 mm).
 - 5. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch (25 mm).
 - 6. Vertical Alignment of Tie Bars and Dowels: 1/4 inch (6 mm).
 - 7. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch (13 mm).
 - 8. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches (6 mm per 300 mm).
- 9. Joint Spacing: 3 inches (75 mm).
- 10. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
- 11. Joint Width: Plus 1/8 inch (3 mm), no minus.

END OF SECTION

SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 1. Parking-stall lines and related accessibility pavement markings
- B. Related Sections1. Section 32 12 16, Asphaltic Concrete Paving
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ADA Americans with Disabilities Act of 1990, as amended
 - 1. ADA Standards ADA Title II Regulations and the 2010 ADA Standards for Accessible Design
 - C. APCD Air Pollution Control District of San Diego County
 - 1. APCD-67.0 APCD Regulation IV, Rule 67.0, Architectural Coatings
 - 2. APCD-67.21 APCD Regulation IV, Rule 67.21, Adhesive Material Application Operations
 - D. ASTM American Society for Testing and Materials
 - 1. ASTM C 881 Epoxy-Resin-Base Bonding Systems for Concrete
 - 2. ASTM D 788 Classification System for Poly(Methyl Methacrylate) (PMMA) Molding and Extrusion Compounds
 - E. CALTrans California Department of Transportation
 - 1. CALTrans Manual CALTrans, Manual for Uniform Traffic Control Devices
 - 2. CALTrans Specifications CALTrans, Standard Specifications
 - F. CBC 2016 California Building Code (CCR Title 24, Part 2)
 - 1. CBC-11B CBC Chapter 11B, Access to Public Buildings, Public Accommodations, Commercial Facilities and Publicly Funded Housing
 - G. Fed.Std / Fed.Spec Federal Standard / Federal Specification
 - 1. Fed.Std-595C Colors Listed in Government Procurement
 - 2. Fed.Spec TT-P-1952D Paint, Traffic and Airfield Marking, Waterborne
 - H. SCAQMD South Coast Air Qaulity Management District
 - 1. SCAQMD-1113 SCAQMD Rule 1113, Architectural Coatings
 - 2. SCAQMD-1168 SCAQMD Rule 1168, Adhesive and Sealant Applications
 - I. SSPWC Standard Specifications for Public Works Construction (California)

1.03 SUBMITTALS

- A. Action Submittal
 - 1. Product Data for each paint system product and accessory item Shop Drawings of traffic and parking markings
- B. Record Submittals
 - 1. Manufacturer's Application Instructions
- 1.04 QUALITY ASSURANCE
 - A. Paints and Coatings: VOC content within limits set by SCAQMD-1113.
 - B. Adhesives and Sealants shall have VOC content within limits required by SCAQMD-1168.
 - C. Regulatory Requirements
 - 1. Pavement markings for designated accessible parking spaces and related pedestrian stripping shall conform to ADA Standards or CBC-11B whichever provides persons with disabilities greater protection.
 - 2. Traffic control pavement and curb markings shall be in accordance with SSPWC, Sections 210-1.6 and 310-5.6.
 - 3. Paint products shall dry to a finish as slip resistant as surrounding pavement.
 - 4. Detectable warning textures shall be as specified in Section 32 13 13.
 - D. Manufacturer: company with minimum 10-years' experience manufacturing traffic line paint products for commercial projects similar in scale, complexity and quality to those required for this Project.
 - E. Installer: company with minimum 6-years' experience painting traffic and related pavement markings for commercial projects similar in scale, complexity and quality to those required for this Project.
 - F. Field Samples
 - 1. Provide field sample, illustrating coating color, width of stroke, thickness of application and dimensioning.
 - 2. Location: acceptable to Architect.
 - 3. Modify materials and methods of installation as required to obtain Architect's approval.
 - 4. Document materials and methods used to obtain Architect's approval. Maintain at least one copy of this documentation in a readily accessible location on Site while this work is in progress.
 - 5. Maintain access to and protect Field Sample from damage while this work is in progress.
 - 6. Upon acceptance of related work, Field Sample in acceptable condition may remain as part of the work.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site in manufacturer's original, sealed containers with labels legible and intact.
 - 1. Labels shall include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation and instructions for mixing and reducing.
- B. Store paint materials at ambient temperatures between 45- and 90-degrees-F, unless expressly permitted otherwise in manufacturer's printed instructions.

1.06 MAINTENANCE

- A. For each color of pavement marking paint furnish, as Extra Material, [a five-gallon unopened] [a quantity equal to approximately 3-percent of quantity required for its installation rounded up to next higher five-gallon] container of the paint.
 - 1. Extra Materials shall be from same production run as installed materials.
 - 2. In addition to manufacturer's label, label each container for color, dates and locations of related installations and shelf life.
 - 3. Deliver Extra Materials to Owner as directed.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Accessible Parking:
 - 1. Accessible parking spaces shall be located as near as practical to a primary entrance and shall be marked according to CBC Section 11B-208.3.1
 - 2. Accessible parking spaces serving a particular building or facility shall be located on the shortest accessible route to an entrance complying with CBC Section 11B-208.3.1.
 - 3. Accessible parking spaces serving more than one accessible entrance shall be dispersed and located on the shortest accessible route to the accessible entrances.
 - 4. Accessible parking spaces in a parking facility not serving a particular building or facility shall be located on the shortest accessible route to an accessible pedestrian entrance of the parking facility. CBC Section 11B-208.3.1.
 - 5. Minimum number of required accessible parking spaces shall be provided in accordance with CBC Table 11B-208.2 for each parking facility provided on a site.
 - 6. For every six or fraction of six accessible parking spaces, at least one shall be an accessible van parking space. CBC Section 11B-208.2.4.
 - 7. Accessible parking spaces and access aisles shall comply with CBC Section 11B-502 and shall be dimensioned to the centerline of the marked lines as follows:
 - a. Parking spaces and access aisles shall be marked according to CBC Figures 11B-502.2, 11B-502.3, and 11B-502.3.3. Their surfaces shall comply with 1:48 in any direction. CBC Section 11B-502.4.

- b. Parking spaces shall be 9' x 18' minimum and van parking spaces shall be 12' x 18' minimum with an adjacent access aisle of 5' x 18' minimum. Access aisles shall be placed on either side of the parking spaces except be located on the passenger side for van parking spaces. Van parking spaces shall be permitted to be 9' x 18' minimum where the access aisle is 8' x 18' minimum
- c. Access aisles shall be marked by a blue painted borderline around their perimeter. The area within the blue borderlines shall be marked with hatched lines a maximum of 36" on center in a color contrasting with that of the aisle surface, preferably blue or white. Access aisle markings may extend beyond the minimum required length. CBC Section 11B-502.3.
- d. Access aisles (accessible parking spaces as well similar application) shall not overlap the vehicular way. CBC Section 11B-502.3.4.
- e. A vertical clearance of 8' 2" minimum shall be provided for accessible parking spaces, access aisles, and vehicular routes serving them. CBC Section 11B-502.5.
- B. Accessible parking spaces shall be located as near as practical to a primary entrance and shall be marked according to CBC Section 11B-208.3.1
- C. Surface slopes of accessible parking spaces and access aisles shall be the minimum possible and shall not exceed 2% slope in any direction. CBC Section 11B-502.4
- D. Loading and unloading access aisle shall be marked by a border painted blue. Within the blue border, hatched lines a maximum of 36" on center shall be painted a color contrasting with the parking surface, preferable blue or white. CBC Figures 11B-502.3.3.
 - 1. The words "NO PARKING" shall be painted on the surface within each access aisle in white letters a minimum of 12" high and located to be visible from the adjacent vehicular way.
- E. ISA Markings: Each accessible car and van space shall have surface identificaiton complying with 11B-502.6.4.
- F. When blue color is used, it shall conform to Color No. 15090 per Federal Standard 595C.
- G. Painted lines and markings on pavement are recommended to be 3" wide minimum.
- 2.02 PAVEMENT MARKING PAINTS
 - A. Acceptable Manufacturers. Products of following manufacturers form basis of design and quality intended for this Project.
 - 1. Dunn-Edwards Corporation, Los Angeles, CA
 - 2. Glidden Professional, Commerce, CA
 - 3. Sherwin Williams
 - 4. Or equal, approved in accordance with Division 01 requirements for substitutions.
 - B. Traffic Line Paint: lead and chromate free, ready mixed, waterbourne emulsion type, complying with Fed.Spec TT-P-1952D with drying time of less than 45 minutes. Furnish paints in containers of at least 18 L (5 gallons).

- 1. Colors
 - a. Accessible Markings for Parking Stalls, Passenger Drop-Off Area and Related Markings: Fed.Std 595C, Color No. 15090, Blue, except that International Symbol of Access and NO PARKING notices marked on pavement shall be white. Section 11B-502.6.4.
 - b. Other Parking Stall Lines and Traffic Control markings: white.
 - c. Fire Lane markings: red with white lettering.
 - d. Temporary Parking, markings: green with white lettering.
 - e. Passenger / Postal Loading Zones, markings: white with black lettering.
 - f. Commercial Loading Zone markings: yellow with black lettering.
- 2. Acceptable Products
 - a. Dunn-Edwards, Vin-L-Stripe Traffic Paint, Vinyl Epoxy Emulsion, W801
 - b. Glidden Pro, Traffic Paint 4810, Fast Dry Acylic
 - c. Sherwin Williams, SetFast Acrylic Waterborne Traffic Marking Paint, White, TM226.
 - d. Or equal
- 2.03 ACCESSORIES
 - A. Adhesive: ASTM C 881, Type IV Grade, 3, Class B epoxy type, rapid set, CALTrans Manual, Sections 85-1.055 and 95-2.04.
- PART 3 EXECUTION
- 3.01 EXAMINATION
 - A. Verify that surfaces are ready to receive Work as instructed by product manufacturer.
 - B. Do not begin installation until unsatisfactory conditions are corrected. Beginning installation means acceptance of existing conditions including the preparatory work of others, if any.
- 3.02 PREPARATION
 - A. Clean pavement in immediate vicinity of markings as directed by paint manufacturer.
 - 1. Surfaces to be painted shall be clean and free of dust, dirt, grease, oil, water or other contaminates.
 - 2. Existing lines to be removed shall be sandblasted clean.
 - B. Do not apply traffic paint to AC paving until seal coat has been in place minimum of 10 days.
- 3.03 APPLICATION
 - A. Apply paints by machine spray, airless sprayer, roller or brush to provide a minimum DFT of 15 mils. Precise edges are required; no overspray will be accepted.
 1. Stripping: single, 4 inch wide lines, unless double lines are shown on drawings.
 - B. Perform Work in accordance with approved Shop Drawings and with SSPWC Section 310-5.6.8.

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1. Striping, pavement markings, and curb markings shall be in accordance with SSPWC Sections 210-1.6 and 310-5.6 or accessibility requirements, as applicable.

3.04 DEFECTIVE WORK

A. Remove any paint that demonstrates evidence of checking, cracking, peeling, discoloration, lack of bonding or poor coverage. Misplaced lines shall be completely removed by paint remover or wet abrasive-blasting in accordance with SSPWC, Section 310.5.6.3. Painting over misplaced lines will not be permitted. Provide new complying work without claim for change in Contract Sum or Schedule.

END OF SECTION

SECTION 32 17 26

DETECTABLE/TACTILE WARNING SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division 1 Specifications Section, apply to this Section.

1.2 DESCRIPTION

A. This Section specifies furnishing and installing precast concrete Detectable/Tactile Warning Surface Tiles set on concrete, where indicated.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.
- B. Samples for Verification Purposes: Submit two (2) tile samples minimum 12" x 12" of the kind proposed for use.
- C. Shop drawings are required for products specified showing fabrication details, composite structural system, tile surface profile, sound on cane contact amplification feature, plans of tile placement including joints, and material to be used as well as outlining installation materials and procedure.

1.4 QUALITY ASSURANCE

- A. Provide Cast in place detectable/tactile warning surface tiles and accessories as produced by a single manufacturer with a minimum of five (5) years experience in the manufacturing of Cast In Place Detectable/Tactile Warning Surface Tiles.
- B. Installer's Qualifications: Engage an experienced Installer certified in writing by Cast in place detectable/tactile warning surface tile manufacturer as qualified for installation, who has successfully completed installations similar in material, design, and extent to that indicated for Project.
- C. Americans with Disabilities Act (ADA): Provide Surface Applied Detectable/Tactile Warning Surface Tiles which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title III Regulations, 28 CFR Part 36 ADA Standards For Accessible Design, Appendix A, Section 4.29.2 Detectable Warnings On Walking Surfaces).

D. California Code of Regulations (CCR): Provide only approved DSAAC detectable warning products as provided in the California Code of Regulations (CCR) Title 24, Part 2, Section 205 definition of "Detectable Warning", section 11B-705.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Cast in place detectable/tactile warning surface tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect tile from concrete residue during installation and tile type shall be identified by part number.
- B. Cast in place detectable/tactile warning surface tiles shall be delivered to location at building site for storage prior to installation.

1.6 SITE CONDITIONS

- A. Environmental conditions and protection: Maintain minimum temperature of 40°F in spaces to receive Cast in place detectable/tactile warning surface tiles for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.
- B. The use of water for work, cleaning or dust control, etc. shall be contained and controlled and shall not be allowed to come into contact with the general public. Provide barricades or screens to protect the general public.

1.7 GUARANTEE

A. Cast in place detectable/tactile warning surface tiles shall be guaranteed in writing for a period of five (5) years from date of final completion. The guarantee includes defective work, breakage, deformation, fading and loosening of tiles, per DSA Bulletin 10/1/02, revised 04/9/08.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Precast concrete detectable/tactile warning surface tile shall be by Stepstone, Inc. or equal.
- B. Pavers/tiles shall be precast concrete, consisting of Portland cement, aggregate, and color admixtures.
 - 1. Portland Cement: ASTM C 150, Type III, high early strength.
 - 2. Aggregate: ASTM C 33.
 - 3. Color Admixture. By Davis Colors, or equal, as required to achieve color as selected.

- 4. Mortar that meets or exceeds ANSI A118.4 requirements when mixed with water or a latex admixture, and is designed for installation of large format tile.
- 5. Grout that meets or exceeds ANSI A118.7 when mixed with water or latex admixture.
- C. Color: Yellow conforming to Federal Color No. 33538 per Federal Standard No. 595B, CBC Section 1133B.8.5 and 1121 B.3.1, Item 8(a). Color shall be homogeneous. Unless otherwise indicated on Drawings, color shall match existing adjacent products.
- D. Finishes: Walking surfaces of precast concrete paving units shall have minimum coefficient of friction of 0.60, wet and dry.
- E. Weight: 22 pounds per square foot.
- F. Precast concrete paving units shall have a minimum compressive strength of 5,000 psi.
- G. Water absorption: Not more than 8.8 percent average, not more than 9.8 percent for any individual unit.
- H. Resistance to Freeze-Thaw: Pavers shall resist 50 freeze thaw cycles in accordance with ASTM C1645 Standard test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units.

2.2 FABRICATION

A. Pavers shall be fabricated of cement conforming to ASTM C 150, Type III, aggregates conforming to ASTM C 33, and pigments for integrally colored concrete conforming to ASTM C979.

2.3 SOURCE QUALITY CONTROL

A. Concrete for precast concrete surface tile shall be tested frequently to assure that mixes provide units having not less than 5,000 psi compressive strength. At 28 days (average test strength not less than 4,500 psi).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine all surfaces.
- B. Verify all dimensions of in-place and subsequent construction.
- C. Notify the Owner in writing of conditions detrimental to the proper and timely completion of work.

E. Installation of precast concrete pavers and associated construction constitutes acceptance of the adjacent and underlying construction.

3.2 INSTALLATION-GENERAL

- A. Installation shall comply with requirements of applicable building codes and state and local jurisdictions.
- B. Install precast concrete tiles in a thin-set mortar bed in accordance with the specifications defined in the CTMA Handbook for Concrete Tiles, available at www.concretile.org
 - 1. Follow manufacturer's instructions for thin-set use.
 - 2. 100% paver bonding coverage is recommended, with a minimum acceptable coverage of 95% for exterior installations or 80% for interior installations. Backbuttering is mandatory to obtain a minimum of 95% coverage.
 - 3. Clean any mortar off the face of the pavers immediately. Never leave a 'cement haze' on the concrete paver's surface.
- C. Provide for expansion and control joints as specified per TCA detail EJ-171-current year. Follow expansion and control joint materials manufacturer's instructions.

3.3 CLEANING

A. Clean exposed surfaces of precast concrete paving units. Use cleaners appropriate for precast concrete finishes and colors. Acid based cleaners will permanently alter finish and color.

3.4 SEALING

A. If precast concrete paving units are factory sealed, generally do not apply additional sealer. Verify with precast manufacturer and sealer manufacturer if it is desired to apply additional sealer. If precast concrete paving units are not sealed in the factory, sealer shall be applied.

3.5 COMPLETION

- A. Protect precast concrete paving units from damage due to subsequent building operations.
- B. After installation and before completion, inspect precast concrete paving units for construction damage and obtain new precast concrete paving units if required.
- C. Immediately prior to final acceptance of project, clean precast concrete paving units.

SECTION 32 31 13

FENCES AND GATES

PART 1 - GENERAL

- 1.01 SECTION INCLUDES
 - A. Fence framework, fabric, and accessories
 - B. Excavation for post bases.
 - C. Concrete anchorage for posts and center drop for gates.
 - D. Swing gates, signs and related hardware.1. Manual operation
 - E. Related Section1. Section 32 13 13, Sitework Concrete.
- 1.02 REFERENCE STANDARDS
 - A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
 - B. ASTM International
 - 1. ASTM A 392 Zinc-Coated Steel Chain-Link Fence Fabric
 - 2. ASTM A 824 Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence
 - 3. ASTM F 552 Terminology Relating to Chain Link Fencing
 - 4. ASTM F 567 Installation of Chain-Link Fence
 - 5. ASTM F 626 Fence Fittings
 - 6. ASTM F 900 Industrial and Commercial Swing Gates
 - 7. ASTM F 1043 Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework
 - 8. ASTM F 1083 Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
 - 9. ASTM F 1184 Industrial and Commercial Horizontal Slide Gates
 - **10.** ASTM F 2049 Fences/Barriers for Public, Commercial, and Multi-Family Residential Use Outdoor Play Areas.
 - 11. ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - C. SSPWC Standard Specifications for Public Works Construction, Latest Edition
 - D. CLFM Chain Link Fence Manufacturer's Institute
 - E. CBC 2016 California Building Code
 - 1. Chapter 10, Means of Egress

- 2. Chapter 11B, Accessibility to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing.
- 3. Chapter 19A, Concrete
- F. National Ornamental and Miscellaneous Metals Association (NOMMA)
 1. NOMMA Guidelines Guideline 1 Joint Finishes
- 1.03 QUALITY ASSURANCE
 - A. Manufacturer: Company specializing in commercial quality chain link fencing with five years experience.
- 1.04 SUBMITTALS
 - A. Shop drawings including plan layout, grid, spacing of components, accessories, fittings, hardware, footings, anchorages and schedule of components.
 - B. Product data.
 - C. Manufacturer's installation instructions.
 - D. Three samples illustrating each fence fabric finish.

1.05 WARRANTY

- A. Provide two-year warranty to insure materials against rusting or breakdown of finish. Provide adjustments as needed to assure continued smooth operation of gates.
- PART 2 PRODUCTS
- 2.01 MATERIALS
 - A. Acceptable Manufacturers
 - 1. Master-Halco/Anchor Fence Inc., Baltimore, MD
 - 2. Boundary Fence and Railing Co., Richmond, NY.
 - 3. Reeves Southeastern Wire Corp., Tampa, FL.
 - 4. Ameristar Fence Products, Tulsa, OK.
 - 5. Or equal in accordance with Division 01, General Requirements for substitutions.
 - B. Framework: ASTM F1043; Type I Group IA, Schedule 40, ASTM F1083, 50,000 psi, hot-dipped galvanized steel pipe, minimum 1.8 oz/sq.ft. Sized in accordance with Table 206-6.2, Standard Specifications for Public Works Construction. One piece without joints in accordance with CLFM I.
 - 1. EXIT Gates: galvanized square tube, ASTM A500, Grade B, for square pipe at lintels and gate posts, minimum galvanizing coating of 1.8 ounces per sq. ft. 2-1/2 inches square.
 - C. Fabric: Type II ASTM A817, Class 2 ASTM A392, Class 2 (not less than 2 oz/ft sq.), galvanized before (G.B.W.) [after (G.A.W.)] weaving, 2-inch mesh, 9 gauge, interwoven, top and bottom knuckled selvage. Single width fabric.

2.02 CONCRETE MIX

- A. Concrete: Normal Portland cement; 3,000 psi at 28 days; 4 inch slump, conforming to ACI 318-11 Section 5.2, CBC Section 1905A and Section 32 13 13 Sitework Concrete.
 - 1. Design Mix: Conform to Section 1905A.1 CBC.
 - 2. Reinforcement: as indicated on drawing 4/A10.01
- 2.03 COMPONENTS
 - A. Nominal pipe size (NPS) and weight (Class 1) in pounds per lineal foot: NPS Pounds/LF

1. 2. 3. 4. 5.	1-1/4: 1-1/2: 2: 2-1/2: 3:	 2.27 2.72 3.65 (3.87 for sq. pipe at exit gate frames) 5.79 (5.79 for sq. pipe at exit gate posts) 7.58
4.	2-1/2:	5.79 (5.79 for sq. pipe at exit gate posts)
5.	3:	7.58
6.	3-1/2:	9.11
7.	6:	18.97
8.	8:	24.58

B. Line Posts for fencing Fence height in feet Outside diameter in inches

- 1.
 6 to 7.9
 2.375

 2.
 8
 4
- C. Terminal Posts end, corner and slope. Fence height in feet Outside diameter in inches 1. 8 4
- D. Swing gate posts, single leaf; opening widths in feet:
 1. Up to 6 wide 4 inches diameter
- E. Top rail, mid rails, and braces: 2-1/2 inches diameter, plain end, sleeve coupled.
- F. Top Rail Expansion Sleeve: 7 inches expansion sleeve with spring.
- G. Swing Gate Frames: 2-1/2 inches diameter
- H. Stiffeners for swing gates:1-1/4 inches diameter
- I. Caps: Domed cast steel or malleable iron, galvanized and coated; sized to post dimension, set screw retained.
- J. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings: Galvanized Steel.
- K. Tension Wire: 7 gage thick coil spring steel, single strand, galvanized.

- L. Truss Rod and Tightener: 3/8-inch diameter; furnish one at each end, pull, and gate post, and at both sides of corner posts.
- 2.04 PRIVACY DECORATIVE SLATTING
 - A. Slatting: Flat tubular profile, wall thickness of .030 inch, polyethylene, pigmented with ultra violet inhibitor, bottom locking, width to conform to mesh specified PDS FENCE SLATS, by A & B Plastics, Selah, WA, Master-Halco/Anchor Fence Inc., Baltimore, MD.
 - B. Color: As selected by Architect.
 - C. Or equal as approved in accordance with Division 01, General Requirements for Substitutions.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install framework, fabric, accessories and gates in accordance with Section 304-3, SSPWC, ASTM F567 and manufacturer's instructions.
 - 1. Line post-footing diameter: 18 inches minimum. Refer to 4/A10.01 for more information. Slope at top to shed water, 1/4" per foot.
 - 2. Line post-footing minimum depth: 7'-6" minimum
 - 3. Gate post-footing diameter: 18" diameter minimum
 - 4. Gate post footing minimum depth: 7'-6"
 - 5. Reinforcing: per Section 32 13 13 and as indicated on drawings.
 - 6. Posts set in hard rock concrete: drill holes 1 inch larger than post and set in non-shrink grout.
- B. Provide fence height as indicated on Drawings.
- C. Space line posts at intervals not exceeding 10 feet.
- D. Set terminal, gate and line posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.
- E. Provide top rail through line post tops and splice with 7 inch long rail sleeves, outside sleeve type.
- F. Brace each gate, corner, and end posts to adjacent line posts with horizontal center brace rail and diagonal truss rods. Install brace rail, one bay from end and gate posts.
- G. Center Rails: Install mid rails between posts with fittings and accessories for fabric height 12' and over, inclusive.
- H. Install center and bottom brace rail on gate leaves, welded construction.

- I. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
- J. Position bottom of fabric 2 inches above finished grade.
- K. Fasten fabric to top rail, line posts, braces and bottom tension wire with tie wires maximum 16 inches on centers, one complete wrap.
- L. Attach fabric to end, corner and gate posts with tension bars and tension bar clips.
- M. Install bottom tension wire stretched taut between terminal posts, (corner posts shall have brace rail).
- N. Provide concrete center drop and drop rod retainers at center of double gate openings, except gates with panic hardware.
- 3.02 SWING GATES
 - A. Gates that are part of the accessible route shall meet all the requirements of an accessible door in compliance with CBC 11B-404.
 - B. Gate Frames: 2-1/2 inch diameter steel pipe, welded corners, hot dip galvanized after fabrication.
 - C. Sizes: As indicated on the Drawings, minimum widths of gates shall not be less than 36" (clearance of opening width shall not be less than 32 inches).
 - D. Hardware: Heavy-duty, galvanized ferrous metal industrial quality as manufactured by Master-Halco/Anchor Fence Inc., Baltimore, MD. Von Duprin, Adams Rite, Sargent, Trimco or equal as approved in accordance with Division 01, General Requirements for substitutions.
 - 1. Latch: Fork type latch capable of retaining gate in closed position, except gates with exit devices (panic hardware); Master-Halco, Series 16000 or approved equal.
 - a. At accessible gates, hardware shall not require pinching, grasping or twisting motion. Weld 1-1/2 inches by 2-1/2 inches by 1/4 inch diameter U-shaped galvanized rod to fork latch, both sides, for ADA accessibility as indicated on Drawings. Dress welded joints, leaving no burrs, or sharp abrasive corners, edges or surfaces, in accordance with NOMMA Guidelines for Finish 1. Touch up with Solder Zinc Alloy for Repair: Welco Gal-Viz self-fluxing solder alloy, Galvalloy, Galvabar or equal, ASTM A780, paragraph A1. Repair Using Zinc-Based Alloys.
 - 2. Locks: Self-latching bolt and deadbolt, 3/4 inch diameter, adjustable, lockable, with lever handle, by Ameristar Lock or equal, keyed lock. Hardware shall not require pinching, grasping or twisting motion. The lever of lever-activated latches or locks for an accessible gate shall be curved with a return to within 1/2" of the (face of) gate to prevent catching on the clothing or persons.

- 3. Exit Device at Exit Gates only, outswing in accordance with 2016 CBC Sections 1008.1.9, 1008.1.10, and 1008.2, mounted 36" to 44" above finish floor. Exit Device (panic hardware) shall be mounted to provide 36" clear minimum below the device. Unlatching force not exceed 15# applied in direction of travel.
 - a. Panic Bar: Exit Device: Sargent 3828F Series exit device, with sprayed alum enamel finish, 649 strike, and Trim Pack 28-K-LL, with 34 Series rim type cylinder for key operation, outside lever at single gates, devices in exit pathways where shown on drawings, attach to gate post, include cylinder. Lever handle on exterior of gate shall be curved with a return to within ½" of the face of gate to prevent catching on the clothing or persons.
 - b. Accessories: 4" x 3" x ¼" x 8" high galv. steel angle welded to strike-side frame and 1" x 3" x ¼" thick latch bolt keeper.
- 4. Locking: Provide padlock capability on non-pedestrian gates only. Do not install padlock capability on Exit Gates, gates on Path of Travel with Exit Devices and other pedestrian gates.
- 5. Gate Hardware Mounting: Mount at 34 to 40 inches above walking surface and according to 2016 CBC Sections 1008.1.9 and 1008.2 and 11B-404.2.7, 11B-404.2.9.
 - a. Provide strike strap.
 - b. Bolt keeper.
- 6. Install 0.125 inch thick aluminum protective plate 24 in. high by width of gate behind panic device centered at 40 in. above finish surface. Secure to gate frame with #8 stainless steel screws at 6 in on center.
- 7. Install 0.125 inch thick aluminum kickplate 10 inches high on push side (For larger gates install at both sides), CBC 11B-404.2.10, parts creating horizontal or vertical joints in these surfaces shall be within 1/16" of the same plane as the other and be free of sharp or abrasive edges. Cavities created by added kick plates shall be capped. Secure with #8 stainless steel screws 4 places each kickplate minimum. Clear space below gate shall be 3 inches maximum from walking surface on both sides of the gate.
- 8. Gate Closer for push out installation: ANSI A156.4, Grade 1. linstall hydraulic gate closer, Model Dor-O-Matic SC71, Norton 7501, LCN 4041 [Model Sentinel # SN555 SL], or equal. Arm Rw/PA (regular arm with parallel arm bracket), adapter offset shoe, plate and spacer, TBSRT (thru bolt self reaming and tapping) screws, plate. ADA compliant. With metal cover, aluminum finish. Attached to 2-1/2 inches square lintel. Opening force to be limited to 5 lbs maximum.
- 3.03 All gates intended for pedestrian use, including ticket gates shall comply with all applicable requirements of doors. All gates in the Path of Travel and as indicated on the drawings shall require Exit Devices (panic hardware) as specified above, CBC Sections 11B-404.2.7 ADAAG 4.13.3 and 11B-404.2.9. Signage is not permitted in lieu of accessible or panic hardware.TESTING
 - A. At Architect's option, Contractor shall be required to cut any pipe column after installation to confirm requirements of this Specification. If conformance is confirmed, replacement members shall be installed at Owner's cost. Components not meeting required standards shall be replaced.



END OF SECTION

SECTION 33 11 00

WATER SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Construction of on-site water service facilities and appurtenances, including the installation and testing of water system and services indicated for domestic water services. The Contractor shall furnish and install pressure reducing valves, double check detectors, reduced pressure backflow preventers, blowoffs, air release valves, gate valves and appurtenances, in accordance with the Governing Water District.

1.02 REFERENCES

- A. Geotechnical Report:
 - 1. Geotechnical investigation as been prepared under the direction of the Owner. Investigation is hereby referenced as information for the work of this section. Architect assumes no responsibility for conclusions the Contractor may draw, from information provided. The Contract Documents take precedence over recommendations that may be contained in the investigation and the contractor must obtain approval for any and all deviations from the Contract Documents. Copy of investigation is available at Architect's office. Copy investigation is bound herein as a reference only.
- B. 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.
 - 1. Standard Specifications:
 - a. Standard Specifications for Public Works Construction (Latest Edition).
 - b. CalTrans-Manual of Traffic Controls for Construction and Maintenance Work Zones, Latest Edition.
 - 2. Standard Drawings:
 - a. Standard Drawings, issued by Governing Water District, shall apply to the work to the extent referenced on plans.
 - b. Equivalent Materials List, Governing Water District Standard Specifications.
- C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
 - 1. ASTM D1785 1999 Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120
 - 2. ASTM D2466 2001 (Vinyl Chloride) (PVC) Plastic Pipe Fitting, Schedule 40
 - 3. ASTM D2564 1996 Solvent Cements for Polyvinyl Chloride (PVC) Plastic Pipe and Fittings
 - 4. ASTM D2774 2001 Underground Installation of Thermoplastic Pressure Piping
 - 5. ASTM D2855 1996 Making Solvent-Cemented Joints with Polyvinyl Chloride (PVC) Pipe and Fittings
 - 6. ASTM F402 1999 Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings

- D. AMERICAN WATER WORKS ASSOCIATION
 - 1. AWWA C-900 1997 Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings 4 in. through 12 in., for Water District
 - 2. AWWA C-509 2001 Resilient-Seated Gate Valves for Water Supply Service
 - 3. AWWA C-800 2001 Underground Services Line Valves and Fittings
 - 4. AWWA M-23 2002 PVC Pipe-Design and Installation
 - 5. AWWA M9 1995 Concrete Pressure Pipe
- E. UNDERWRITERS LABORATORIES, INC. (UL)
 - 1. UL 262 1994 Gate Valves for Fire Protection Service, Seventh Edition
 - 2. UL 312 1993 Check Valves for Fire Protection Service Eight Edition
 - 3. UL 789 1993 Indicator Posts for Fire Protection Service, Ninth Edition
- F. UNI-BELL PLASTIC PIPE ASSOCIATION (UBPPA)
 - 1. UBPPA UNI-B-8 1986 Direct Tapping of Polyvinyl Chloride (PVC) Pressure Water Pipe
- 1.03 SUBMITTALS
 - A. Manufacturer's Catalog Data:
 - 1. Pipe and Fittings.
 - 2. Joints and Couplings.
 - 3. Valves, including above-ground double check detector, post indicator valve and gate valves, reduced pressure Back Flow Preventer.
 - 4. Valve and Meter Boxes.
 - B. Manufacturer's standard drawings or catalog cuts.
 - C. Certificates of Compliance:
 - 1. Pipe and Fittings.
 - 2. Pipe Joint Materials.
 - 3. Valves
 - D. Certificates shall attest that products meet the requirements of the Governing Water District and that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within 3 years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Storage:
 - Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

- B. Handling:
 - 1. Handle pipe, fittings, valves, hydrants, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Carry, do not drag pipe to the trench. Store plastic piping, jointing materials that are not to be installed immediately, under cover out of direct sunlight.

PART 2 - PRODUCTS

2.01 WATER SERVICE LINE MATERIALS

- A. Piping Materials:
 - 1. Plastic piping and fittings shall bear the seal of the National Sanitation Foundation for potable water service. Plastic pipe and fittings shall be supplied from the same manufacturer and shall be in accordance with the Governing Water District's, "Equivalent Material List" contained in their standard specifications.
 - a. Polyvinyl Chloride (PVC) Plastic Piping Less Than Six Inches in Diameter: SDR 14 with Class 200 pressure rating manufactured in accordance with AWWA Standard C900, unless otherwise noted. Rubber waterlock rings shall be supplies by pipe supplier.
 - b. Polyvinyl Chloride (PVC) Plastic Piping Six to Twelve Inches in Diameter: SDR 18 with Class 150 pressure rating manufactured in accordance with AWWA standard C900, unless otherwise noted. Rubber water lockrings shall be supplied by pipe supplier.
 - 2. Ductile Iron Piping (DIP): Ductile iron pipe shall be pressure Class 350 with Tyton joints unless otherwise noted on plans and manufactured in accordance with AWWA standard C151. Ductile iron pipe and fitting shall be supplied by the same manufacturer and shall be in accordance with the governing District's approved materials list contained in their standard specifications.
- B. Valves and Valve Covers:
 - 1. Gate Valves and Butterfly Valves:
 - a. Gate valves, including tapping valves, shall be resilient seat gate valves manufactured in accordance with AWWA standard C509.
 - b. Butterfly valves shall be manufactured in accordance with AWWA Standard C504. Both gate valves and butterfly valves shall be listed on Governing Water District's approved materials list.
 - 2. Gate Valve Covers and Gate Cans:
 - a. All gate valve covers shall be 8 inch diameter cast iron, having the letters S.C.W. Co. and the word "Water" in raised letters on top. Gate material shall be 8 inch I.D. PVC pipe, schedule 40.
 - 3. Post Indicator Valves, Double Detector Check Valves, Check Valves and reduced Pressure Backflow Preventers. Comply with the Governing Water District's approved material list.
- C. Precast Meter Boxes and Vaults:
 - 1. Comply with the Governing Water District's approved material list and the standard drawings referenced on the plans.

- D. Water Main Appurtenances:
 - 1. All water main appurtenances including, but not limited to fire hydrants, water meters, fire department connections, air and vacuum release valves, tapping sleeves, blow off assemblies, water services, brass fittings and iron fittings shall comply with the Governing Water District's approved materials list.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPELINES

- A. Installation of all water mains, appurtenances and water service shall conform to the Governing Water District's standard specifications.
- B. The Contractor shall notify Underground Service Alert at 1-800-422-4133 at least two (2) days prior to starting work and shall coordinate all work with utility company representatives. The existence and locations of existing underground facilities indicated on the plans were obtained from a search of available records. The Contractor shall take precautionary measures to protect any existing facility indicated on the plans, and any other which is not of record or indicated on the plans.
- C. Prior to commencing the work, the Contractor shall <u>POTHOLE EXISTING UTILITIES</u> at points of connection, and notify engineer of record of discrepancies.
- D. Contractor shall coordinate locations of stubouts from buildings with building plumbing Contractor.
- E. Installation of Water Service Piping:
 - 1. Location:
 - a. Connect water service piping to the building service where the building service has been installed. Where building service has not been installed, terminate water service lines approximately 5 feet from the building line at the points indicated; such water service lines shall be closed with plugs or caps.
 - 2. Service Line Connections to Water Mains:
 - a. Domestic Service:
 - 1) The Contractor shall be responsible to install the service lateral, 2" ball valve curb stop with PVC pack joint inlet and outlet per the Governing Water District's standard drawings set in a No. 3 Water meter box with extensions. The Contractor shall be responsible to continue water service piping from the 2" water stop to the building terminus as specified in Paragraph 3.01A. above.
 - b. Fire Sprinkler Service:
 - The Contractor shall be responsible to install fire service piping from the connection at main to the building terminus as specified in Paragraph 3.01A. above, including installation of above-ground double check detector assembly, reduced pressure backflow preventer, post indicator valve, thrust blocks, and calculations, and fire department connection as indicated.

- F. Special Requirements for Installation of Water Service Piping:
 - 1. Installation of Plastic Piping:
 - a. Install pipe and fittings in accordance with Section 306-1.2, 306-1.2.13 of the standard specifications and the applicable requirement of ASTM D2774 and ASTM D2855, unless otherwise specified. Handle solvent cements used to join plastic piping in accordance with ASTM F402.
 - Jointing: Make solvent-cemented joints for PVC plastic piping using the solvent cement previously specified for this material; assemble joints in accordance with ASTM D2855. Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer. Make push-on joints in accordance with the recommendations of the manufacturer.
 - 2) Plastic Pipe Connections to Appurtenances: Connect plastic pipe service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.
- G. Pipe Anchorage:
 - 1. Provide concrete thrust blocks for water mains and fire service laterals in accordance with the Governing Water District's standards.
- H. Trenching and Buried Warning Tape:
 - 1. Perform earthwork operations in accordance with Section 31 23 17, Trenching, including installation of buried warning tape.
- I. Disinfection:
 - 1. Flush and disinfect all new water lines including reclaimed water lines and affected portions of existing potable water lines in accordance with AWWA C651. Apply chlorine by the continuous feed method.
- 3.02 FIELD QUALITY CONTROL
 - A. Field Tests and Inspections:
 - 1. The Contractor shall perform pipeline testing in accordance with Section 306-1.4 of the standard specifications and the Governing Water District's standard specifications.
 - 2. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with the drawings and specifications.
 - B. Testing Procedure:
 - Test water mains and water service lines in accordance with the applicable specified standard. Test PVC plastic water service lines made with PVC plastic water main pipe in accordance with the requirements of UNI B3 for pressure and leakage tests. Test water service lines in accordance with applicable requirements of AWWA C600 for hydrostatic testing. No leakage will be allowed at plastic pipe joints.
 - C. Special Testing Requirements:

1. For pressure test, use a hydrostatic pressure 50 psi greater than the maximum working pressure of the system, except that for those portions of the system having pipe size larger that 2 inches in diameter, hydrostatic test pressure shall be not less that 200 psi. Hold this pressure not less than 2 hours. Prior to the pressure test, fill that portion of the pipeline being tested with water for a soaking period of not less than 24 hours. For leakage test, use a hydrostatic pressure not less than the maximum pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

END OF SECTION

SECTION 33 31 00

SANITARY SEWERAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
 - 1. Special fittings for expansion and deflection.
 - 2. Backwater valves.
 - 3. Cleanouts.
 - 4. Corrosion-protection piping encasement.
 - 5. Precast concrete manholes.

1.2 REFERENCED STANDARDS

- A. The editions and specifications and standards referenced herein, published by the following organizations apply to the construction only to the extent specified by the reference.
 - 1. Standard Specifications:
 - a. Standard Specifications for Public Works Construction, (Current Edition).
 - b. Standard Special Provisions of the Regional Standards Committee.
 - c. City of San Diego Standard Special Provisions, Document No. 769345, filed current date.
 - d. California Department of Transportation, "Manual of Traffic Controls, for Construction and Maintenance Work Zones", (Current Edition), Document No. 869159, filed current date.
 - 2. Standard Drawings:
 - a. City of San Diego Standard Drawings, Document No. 769374, filed June 3, 1986.
 - b. American Water Works Association (AWWA).
 - c. UNI-BELL Plastic Pipe Association (UNI).

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene-monomer rubber.

C. FRP: Fiberglass-reinforced plastic. 5015021-100 Palomar College Escondido - HVAC Lab 10.04.2018

- D. LLDPE: Linear low-density, polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.
- H. RTRF: Glass-fiber-reinforced, thermosetting-resin fitting.
- I. RTRP: Glass-fiber-reinforced, thermosetting-resin pipe.
- J. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Submit manufacturers catalog data on pipe to be supplied.
 - 2. Submit affidavit of compliance with this spec and all reference specifications signed by authorized representative of the manufacturers.
 - 3. Special pipe fittings.
 - 4. Backwater valves.
- B. Shop Drawings: For the following:
 - 1. Manholes: Include plans, elevations, sections, details, and frames and covers. Include design calculations, and concrete design-mix report for cast-in-place manholes.
- C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- D. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- E. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Campus or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Campus's Representative no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Campus's Representative's Campus's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.
- 2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS
 - A. Pipe and Fittings: ASTM A 74, Service class.
 - 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.

- C. Shielded, Stainless-Steel Couplings: CISPI 310, with ASTM A 666, Type 301, stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
 - 1. Manufacturers:
 - a. ANACO.
 - b. Dallas Specialty & Mfg. Co.
 - c. Fernco Inc.
 - d. Ideal Div.; Stant Corp.
 - e. Mission Rubber Company; a division of MCP Industries, Inc.
 - f. Tyler Pipe; Soil Pipe Div.
 - g. Or Equal.
 - 2. Couplings for NPS 1-1/2 to NPS 4: 2-1/8-inch- wide shield with 2 bands.
 - 3. Couplings for NPS 5 and NPS 6: 3-inch- wide shield with 4 bands.
 - 4. Couplings for NPS 8 and NPS 10: 4-inch- wide shield with 4 bands.
- D. Heavy-Duty, Shielded, Stainless-Steel Couplings, NPS 10 and Smaller: With ASTM A 666, Type 301 or Type 304, stainless-steel shield; 2 or more stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve
 - 1. Manufacturers:
 - a. ANACO.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. Ideal Div.; Stant Corp.
 - e. Mission Rubber Company; a division of MCP Industries, Inc.
 - f. Tyler Pipe; Soil Pipe Div.
 - g. Or Equal.
 - 2. Couplings for NPS 1-1/2 to NPS 4: 3 inches.
 - 3. Couplings for NPS 5 to NPS 10: 4 inches.

2.5 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

- A. Pipe: ASTM A 746, for push-on joints.
- B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153, for push-on joints.
- D. Gaskets: AWWA C111, rubber.

2.6 DUCTILE-IRON PRESSURE PIPE AND FITTINGS

A. Pipe: AWWA C151, for push-on joints.

- B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153, for push-on joints.
- D. Gaskets: AWWA C111, rubber.

2.7 PVC PIPE AND FITTINGS

- A. PVC Pressure Pipe: AWWA C900, Class [100] [150] [200], for gasketed joints and using ASTM F 477, elastomeric seals.
 - 1. Fittings NPS 4 to NPS 8: PVC pressure fittings complying with AWWA C907, for gasketed joints and using ASTM F 477, elastomeric seals.
 - 2. Fittings NPS 10 and Larger: Ductile-iron, compact fittings complying with AWWA C153, for push-on joints and using AWWA C111, rubber gaskets.
- B. PVC Water-Service Pipe and Fittings: ASTM D 1785, Schedule 80 pipe, with plain ends for solvent-cemented joints with ASTM D 2467, Schedule 80, socket-type fittings.
- C. PVC Sewer Pipe and Fittings:
 - 1. Pipe and Fittings: Shall conform to ASTM D 3033 or ASTM D 3034, shall be SDR 35, with ends suitable for elastomeric gasket joints. Pipe shall meet requirements of UNI-B-10-88.
 - 2. Joints and Jointing Material: Utilize an integral bell and spigot with a solid cross section rubber gasket. Joints shall conform to ASTM D 3212. Gaskets shall conform to ASTM F 477.
 - 3. Pipe Stiffness: Minimum pipe stiffness (@ 5% deflect) shall be 46 for all sizes when tested in accordance with ASTM D 2412.
 - 4. Flattening: There shall be no evidence of splitting, cracking, or breaking when the pipe is tested as follows:
 - a. Flatten specimen of pipe, six inches long between parallel plates in a suitable press until the distance between the plates is forty percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within two to five minutes.
 - 5. Products: Ringtite greenbell PVC sewer pipe, Johns-Manville, Denver, Colorado; Fluidtite PVC sewer pipe, Certainteed Corporation, Anaheim, California; or equal.
- D. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794 pipe, with bell-and-spigot ends; ASTM D 3034 fittings, with bell ends; and ASTM F 477, elastomeric seals.

2.8 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

- B. Sleeve Materials:
 - 1. For Concrete Pipes: ASTM C 443, rubber.
 - 2. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco Inc.
 - c. Logan Clay Products Company (The).
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. NDS Inc.
 - f. Plastic Oddities, Inc.
 - g. Or Equal.
- D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
 - 1. Manufacturers:
 - a. Fernco Inc.
 - b. Logan Clay Products Company (The).
 - c. Mission Rubber Company; a division of MCP Industries, Inc.
 - d. Or Equal.
- E. Nonpressure-Type, Rigid Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. ANACO.
 - b. Or Equal.

2.9 SPECIAL PIPE FITTINGS

- A. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include 2 gasketed ball-joint sections and 1 or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.
 - 1. Manufacturers:
 - a. EBAA Iron Sales, Inc.

- b. Romac Industries, Inc.
- c. Star Pipe Products.
- d. Or Equal.

2.10 CLEANOUTS

- A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 1. Manufacturers:
 - a. Josam Company.
 - b. MIFAB Manufacturing Inc.
 - c. Smith, Jay R. Mfg. Co.
 - d. Wade Div.; Tyler Pipe.
 - e. Watts Industries, Inc.
 - f. Watts Industries, Inc.; Enpoco, Inc. Div.
 - g. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
 - h. Or Equal.
 - 2. Top-Loading Classification: Heavy duty.
 - 3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
 - 1. Manufacturers:
 - a. Canplas Inc.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Plastic Oddities, Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Zurn Light Commercial Specialty Plumbing Products; Zurn Plumbing Products Group.
 - g. Or Equal.

2.11 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 1. Diameter: 48 inches minimum, unless otherwise indicated.
 - 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.

- 3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
- 4. Riser Sections: 4-inch minimum thickness, and of length to provide depth indicated.
- 5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
- 6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
- 7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
- 8. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
- 9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
- 10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
- 11. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint 10-mil minimum thickness applied to **interior** surfaces.
- 12. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
- B. Manhole Cover Inserts: Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
 - 1. Manufacturers:
 - a. FRW Industries; a Syneco Systems, Inc. company.
 - b. Knutson Enterprises.
 - c. L.F. Manufacturing, Inc.
 - d. Parson Environmental Products, Inc.
 - e. Or Equal
 - 2. Type: With drainage and vent holes.

2.12 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.

- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 2 percent through manhole.
 - 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.13 MISCELLANEOUS MATERIALS

- A. Paint: SSPC-Paint 16.
- B. PE Sheeting: ASTM D 4397, with at least 8-mil thickness.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."
- 3.2 STORAGE OF MATERIALS
 - A. Inspect all materials delivered to the site for damage. Store materials on site in enclosures or under protective covering out of direct sunlight. Do not store materials directly on ground. Keep inside of pipes and fittings free of dirt and debris.

3.3 PIPING APPLICATIONS

- A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
 - a. Unshielded flexible or rigid couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
 - 2. Use pressure-type pipe couplings for force-main joints.
- B. Special Pipe Fittings: Use for pipe expansion and deflection. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- C. Gravity-Flow, Nonpressure Sewer Piping: Use any of the following pipe materials for each size range:
 - 1. NPS 3: NPS 6 ductile-iron, gravity sewer pipe or NPS 3 or NPS 4 ductile-iron pressure pipe; ductile-iron standard or compact fittings; gaskets; and gasketed joints.
 - 2. NPS 3: PVC water-service pipe; PVC Schedule 40, water-service-pipe fittings; and solvent-cemented joints.
 - 3. NPS 3: NPS 4 PVC sewer pipe and fittings, gaskets, and gasketed joints.
 - 4. NPS 4: PVC water-service pipe; PVC Schedule 40, water-service-pipe fittings; and solvent-cemented joints.
 - 5. NPS 4: PVC sewer pipe and fittings, gaskets, and gasketed joints.
 - 6. NPS 4: Class [1] [2] [3], nonreinforced-concrete sewer pipe and fittings, gaskets, and gasketed joints.
 - 7. NPS 5 and NPS 6: NPS 6 PVC sewer pipe and fittings, gaskets, and gasketed joints.
 - 8. NPS 5 and NPS 6: NPS 6 Class [1] [2] [3], nonreinforced-concrete sewer pipe and fittings, gaskets, and gasketed joints.

3.4 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install pipe in accordance with ASTM D 2321, UNI-B-5 and the following:

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- C. Inspect each pipe and fitting before lowering the pipe or fitting into the trench. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.
- D. Use implements, tools, and facilities for the safe and proper protection of the pipe. Handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.
- E. When installing piping in trenches, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure for grade at the pipe invert.
- F. Grade the bottom of the trench to the line and grade to which the pipe is to be laid, with allowance for pipe thickness. Remove hard spots that would prevent a uniform thickness of bedding. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities found. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between bell holes, except that the grade may be disturbed for the removal of lifting tackle.
- G. At the location of each joint, dig bell (joint) holes in the bottom of the trench and at the sides to permit visual inspection of the entire joint.
- H. Provide and maintain means and devices at all times to remove and dispose of all water entering the trench during the process of pipelaying. The trench shall be kept dry until the pipelaying and jointing are completed. Removal of water shall be in conformance with specifications in Section 01065.
- I. When the pipelaying is not in progress, including the noon hours, close the open ends of pipe. Do not permit trench water, animals, or foreign material to enter the pipe.
- J. Lay pipe without break, upgrade from structure to structure, with the bell ends of the pipe upgrade.
- K. Do not use the pipe as a drain for removing water that has infiltrated into the trench.
- L. After joint assembly, bring the bedding material up to 1 foot above the top of the pipe. Place and compact the imported sand as directed in Section 02 30 00. The remainder of the backfill shall be native earth backfill, installed per Section 02 30 00.
- M. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- N. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- O. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.
- P. Install gravity-flow, nonpressure, drainage piping according to the following:

- 1. Install piping pitched down in direction of flow, at minimum slope of 2 percent, unless otherwise indicated.
- 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
- 3. Install piping with 36-inch minimum cover.
- 4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
- 5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
- 6. Install ductile-iron, gravity sewer piping according to ASTM A 746.
- 7. Install ductile-iron and special fittings according to AWWA C600 or AWWA M41.
- 8. Install stainless-steel drainage piping according to ASME A112.3.1.
- 9. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
- 10. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
- 11. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- 12. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
- 13. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.
- 14. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
- 15. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
- Q. Install force-main, pressure piping according to the following:
 - 1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 - 2. Install piping with 36-inch minimum cover.
 - 3. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
 - 4. Install ductile-iron special fittings according to AWWA C600.
 - 5. Install PVC pressure piping according AWWA M23 or ASTM D 2774 and ASTM F 1668.
 - 6. Install PVC water-service piping according ASTM D 2774 and ASTM F 1668.
- R. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
 - 1. Hub-and-spigot, cast-iron soil pipe.
 - 2. Hubless cast-iron soil pipe and fittings.
 - 3. Ductile-iron pipe and fittings.
 - 4. Special pipe fittings.
- S. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.
3.5 PIPE JOINT CONSTRUCTION

- A. Apply the joint manufacturer's lubricant to the pipe spigot to assemble the joint. Follow the manufacturer's instructions. Make joints water tight and root tight.
- B. Join gravity-flow, nonpressure, drainage piping according to the following:
 - 1. 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.
 - 2. 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.
 - 3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
 - 4. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
 - 5. Join ductile-iron and special fittings according to AWWA C600 or AWWA M41.
 - 6. Join stainless-steel drainage piping according to ASME A112.3.1.
 - 7. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
 - 8. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
 - 9. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
 - 10. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomericseal joints or ASTM F 794 for gasketed joints.
 - 11. Join fiberglass sewer piping according to ASTM D 4161 for elastomeric-seal joints.
 - 12. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 - 13. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 - 14. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.
- C. Join force-main, pressure piping according to the following:
 - 1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
 - 2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
 - 3. Join PVC pressure piping according AWWA M23 for gasketed joints.
 - 4. Join PVC water-service piping according ASTM D 2855.
 - 5. Join dissimilar pipe materials with pressure-type couplings.

3.6 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.

- C. Construct cast-in-place manholes as indicated.
- D. Install PE sheeting on earth where cast-in-place-concrete manholes are to be built.
- E. Install FRP manholes according to manufacturer's written instructions.
- F. Form continuous concrete channels and benches between inlets and outlet.
- G. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.
- H. Install manhole cover inserts in frame and immediately below cover.

3.7 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318/318R.

3.8 BACKWATER VALVE INSTALLATION

- A. Install horizontal-type backwater valves in piping where indicated.
- B. Install combination horizontal and manual gate valve type in piping and in manholes where indicated.
- C. Install terminal-type backwater valves on end of piping and in manholes where indicated. Secure units to sidewalls.

3.9 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use heavy-duty, top-loading classification cleanouts in vehicle-traffic service areas.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.10 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

- B. Connect pressure, force-main piping to building's sanitary force mains specified in Division 15 Section "Sanitary Waste and Vent Piping." Terminate piping where indicated.
- C. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 - 4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.11 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least [8-inch-] < Insert other> thick, brick masonry bulkheads.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
 - 1. Remove manhole and close open ends of remaining piping.

- 2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Division 2 Section "Earthwork."

3.12 PAINTING

- A. Clean and prepare concrete manhole surfaces for field painting. Remove loose efflorescence, chalk, dust, grease, oils, and release agents. Roughen surface as required to remove glaze. Paint the following concrete surfaces as recommended by paint manufacturer:
 - 1. Cast-in-Place-Concrete Manholes: All interior.
 - 2. Precast Concrete Manholes: All interior.
- B. Prepare ferrous frame and cover surfaces according to SSPC-PA 1 and paint according to SSPC-PA 1 and SSPC-Paint 16. Do not paint surfaces with foundry-applied corrosion-resistant coating.

3.13 IDENTIFICATION

- A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
 - 1. Use detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.14 TESTING FOR ALIGNMENT

- A. After the pipe has been installed, tested for leakage, backfilled to existing grade, and manholes raised to grade and resurfaced, "ball" the pipe from manhole with a sewer scrubbing ball. After balling the pipe, perform the following.
- B. "Mirror" straight sewers and inlet/outlet ends of curvilinear sewers. Perform balling and mirroring in the presence of the Campus's Representative to test for alignment, grade, damage or defective pipe in place, or any other type of faulty installation. Should balling and mirroring indicate any faulty installation of the pipe, repairs or replacements shall be made at the Contractor's expense.

3.15 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test for leakage by means of a water test. Test each section of pipe between manholes, along with the manholes.
 - 3. Even though a section may have previously passed the leakage test, test each section of sewer subsequent to the last backfill compacting operation in which heavy compaction equipment may have damaged or affected the required watertight integrity of the pipe, structure, or appurtenance.
 - 4. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 5. Submit separate report for each test.
 - 6. WATER TEST
 - a. Test each section of pipe between two successive structures by closing the lower end of the pipe to be tested and the inlet pipe of the upper structure with plugs or stoppers. Fill the pipe and structure with water to a point 4 feet above the invert of the open pipe in the upper structure, or to a height of 10 feet above the invert of the sewer in the lower structure, whichever gives the less hydrostatic pressure on the lower structure.
 - b. The total leakage shall be the decrease in volume of water in the upper structure. The leakage shall not exceed 0.025 gpm per inch of nominal diameter of pipe per 1,000 feet of sewer pipe being tested. Do not use the length of lateral connections in computing the length of pipe being tested.
 - c. If the leakage is greater than allowed, overhaul the pipe and, if necessary, replace and relay until the joints and pipe comply with this test. Complete tests before trench is paved.
 - 7. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

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- 8. Option: Test plastic gravity sewer piping according to ASTM F 1417.
- 9. Option: Test concrete gravity sewer piping according to ASTM C 924.
- 10. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.
- 11. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
- 12. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
- 13. Manholes: Perform hydraulic test according to ASTM C 969.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- 3.16 CLEANING
 - A. Clean interior of piping of dirt and superfluous material. Flush with potable water.
- 3.17 CLOSEOUT DOCUMENTATION
 - A. Video Documentation: Upon completion of sitework, hardscaping, landscaping and pipe cleaning, televise and record on DVD storm drain piping installed as part of the Project (outside the building footprint) as follows:
 - 1. Notify Project Inspector at least two days prior to scheduled recording.
 - 2. Include audio narration.
 - B. Report: Prepare a written report of the video documentation, including the following:
 - 1. Camera location, identified by Campus's storm drain numbering system.
 - 2. Pipe sections being viewed.
 - a. Markup pipe section in conjunction with storm drain Drawings.
 - C. Submit DVD, written report, and Drawing markups to Campus in accordance with Division 1 Section "Project Closeout."

END OF SECTION 33 31 00